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Introduction to Normal and Abnormal Fetal Anatomy

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Introduction to Normal and Abnormal Fetal Anatomy

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Adapted from ISUOG Basic training lecture

Learning Objective

At the end of the lecture you will be able to:

- Compare the differences between the ultrasound appearances of normal fetal anatomy and of the more common structural fetal abnormalities.

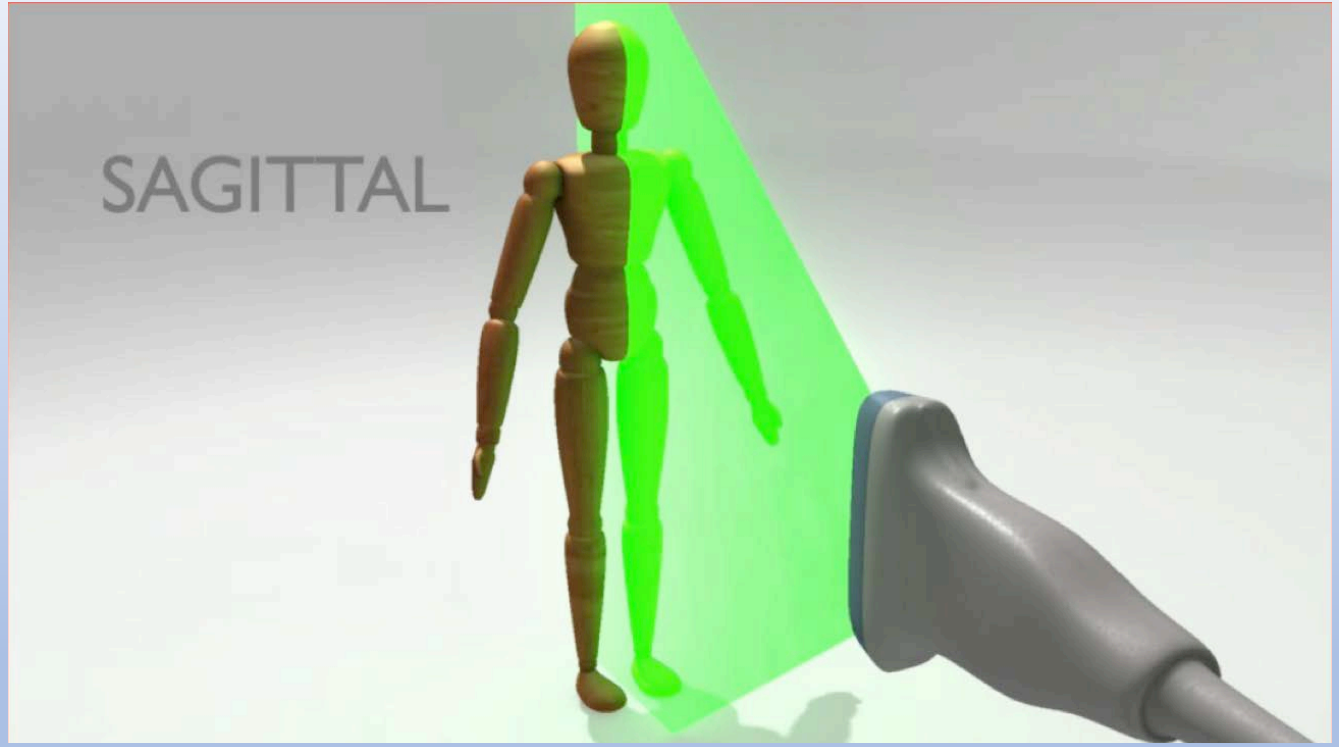
Key Questions

- Which abnormalities can be excluded by obtaining normal HC and AC sections in the 2nd or 3rd trimester fetus?
- What are principal differences in ultrasound appearances between a structurally normal fetus and a fetus with open spina bifida?
- How can the AC section be used to exclude the most common abdominal wall and gastrointestinal defects?
- What are the typical ultrasound features of lower urinary tract obstruction?

Key Anatomic Planes

Scanning Planes

Scanning Planes



Scanning Planes

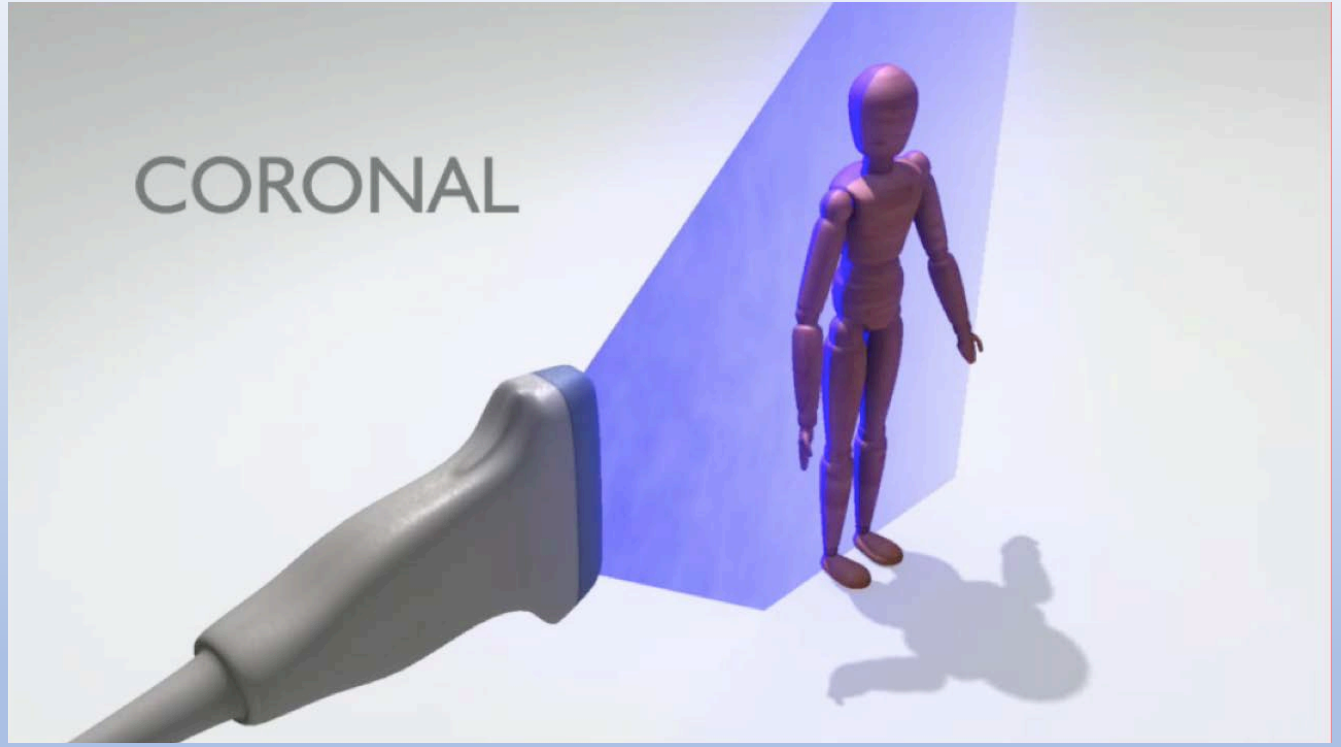
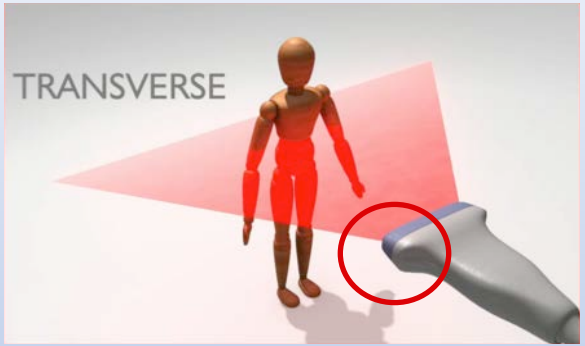
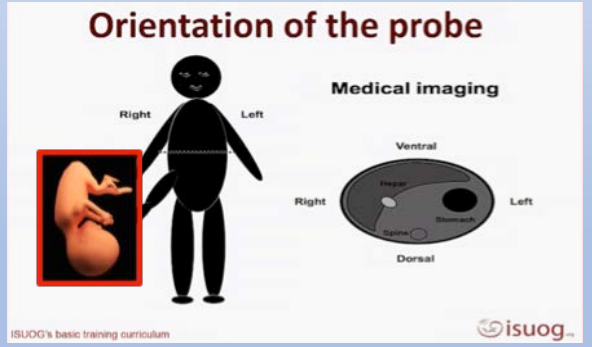


Image Orientation





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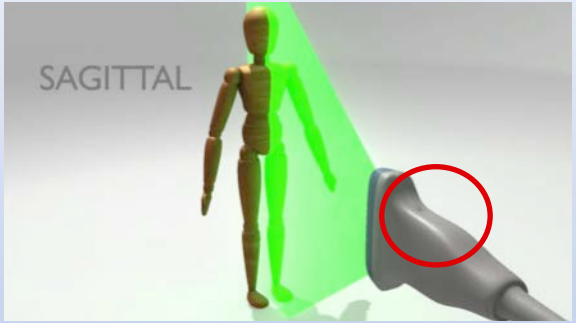
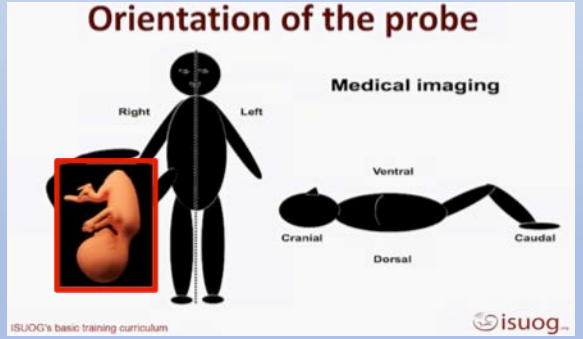
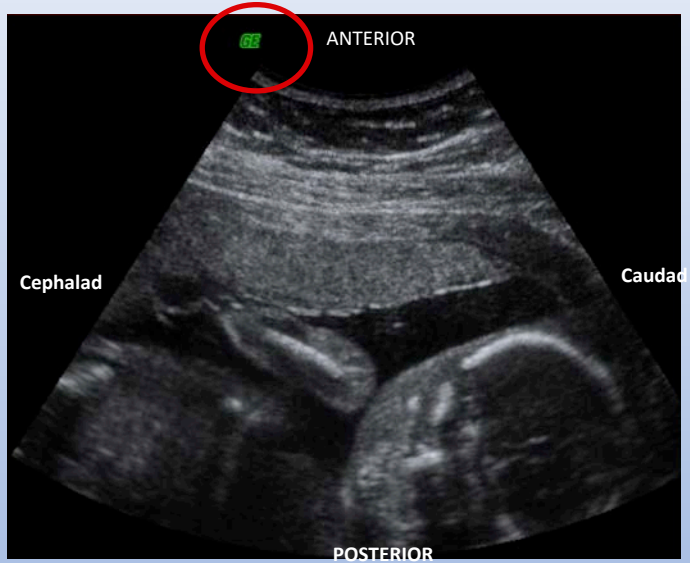
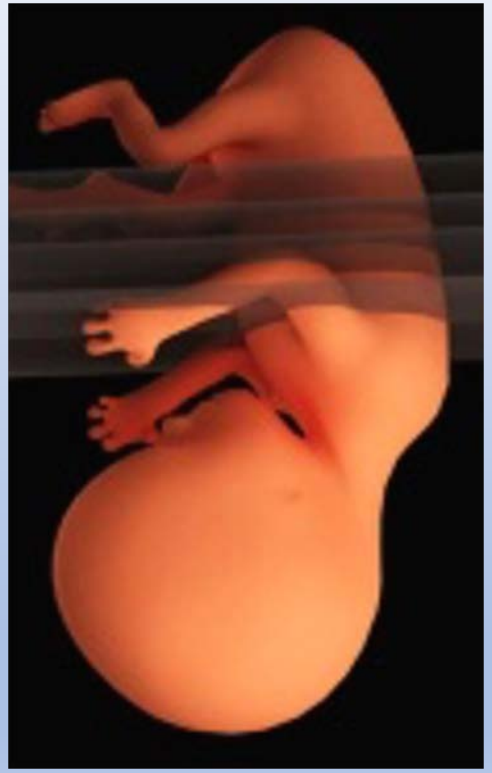
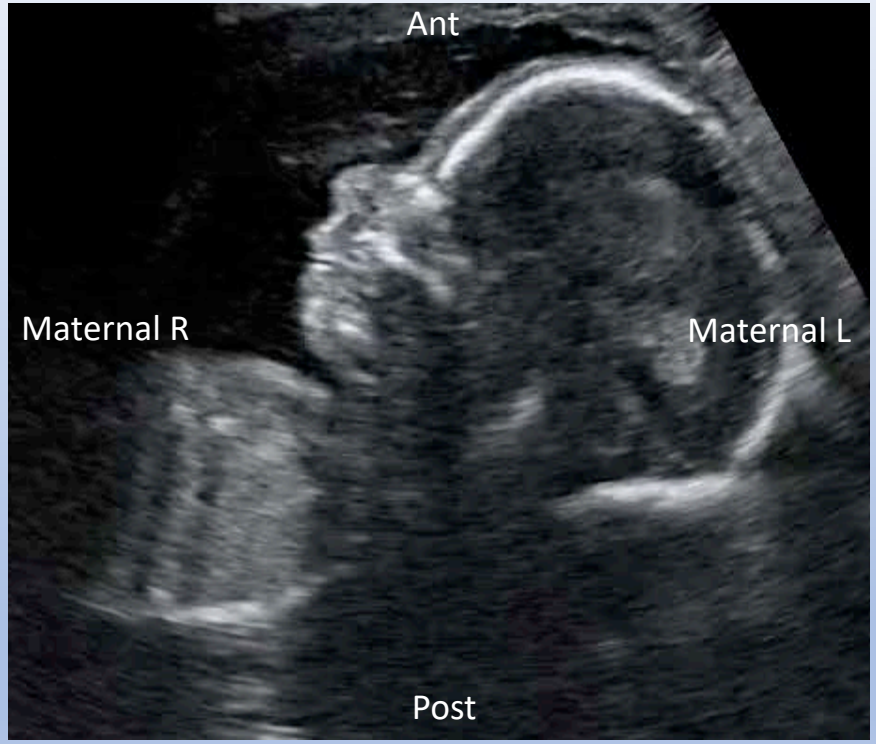




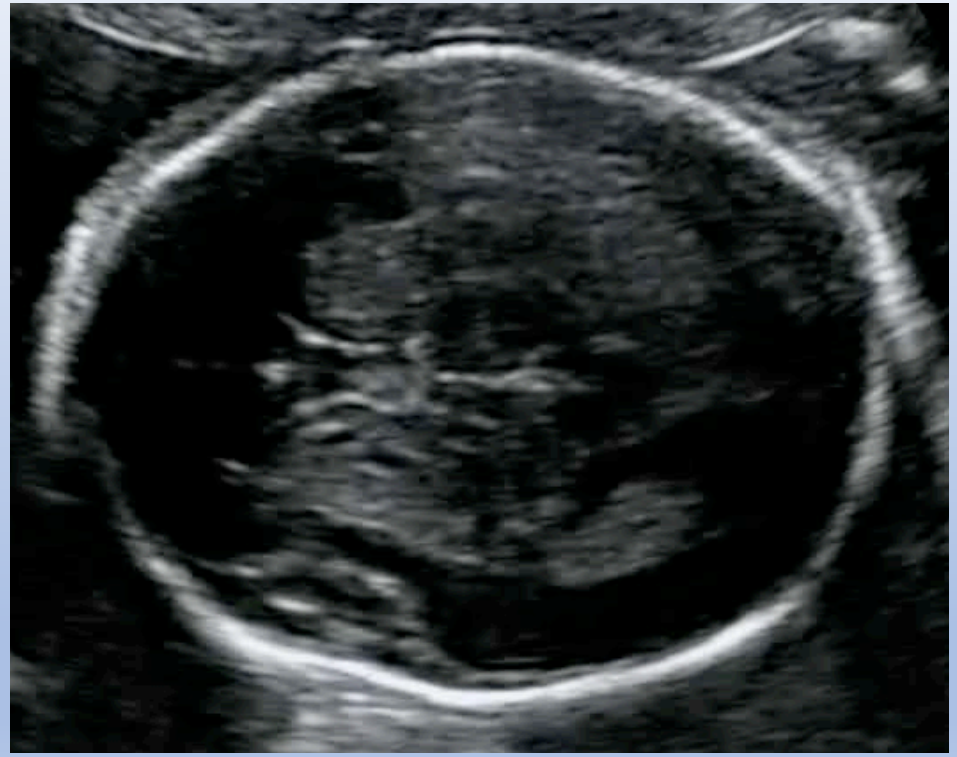


Determining Fetal Lie



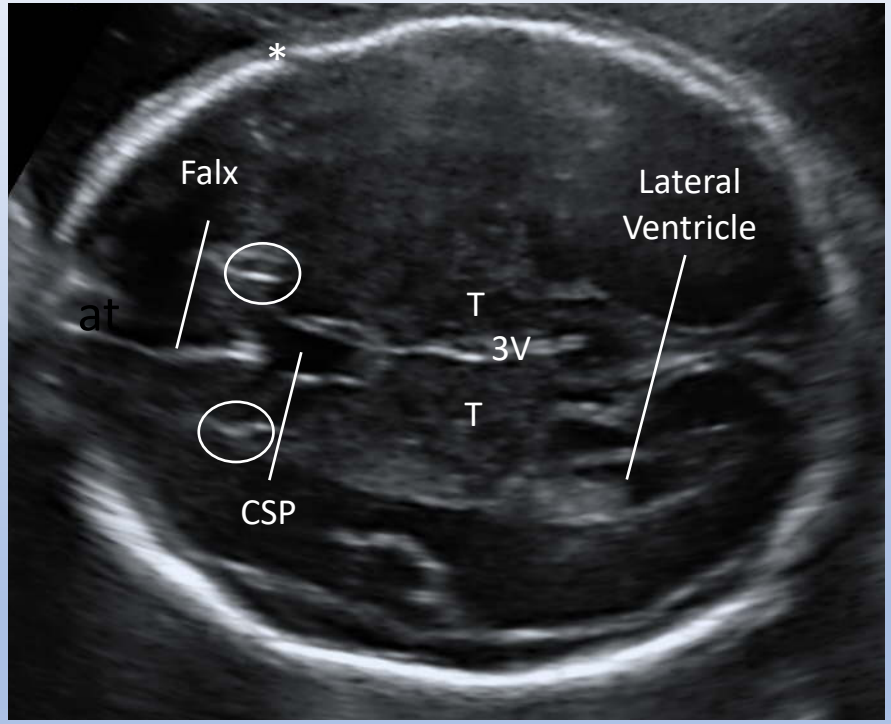


Key Features of HC Section

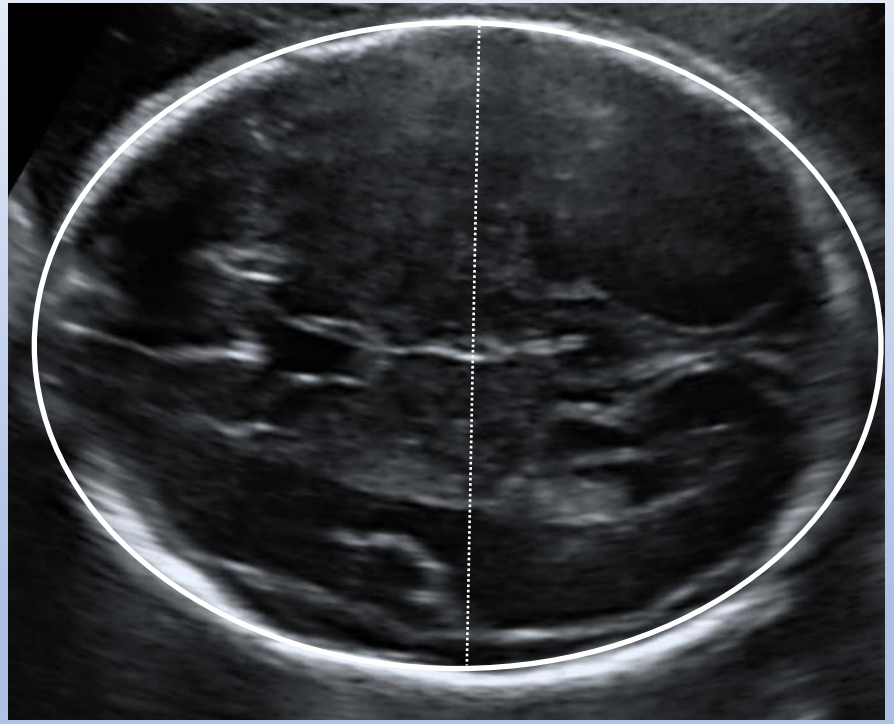


Key Features of HC Section

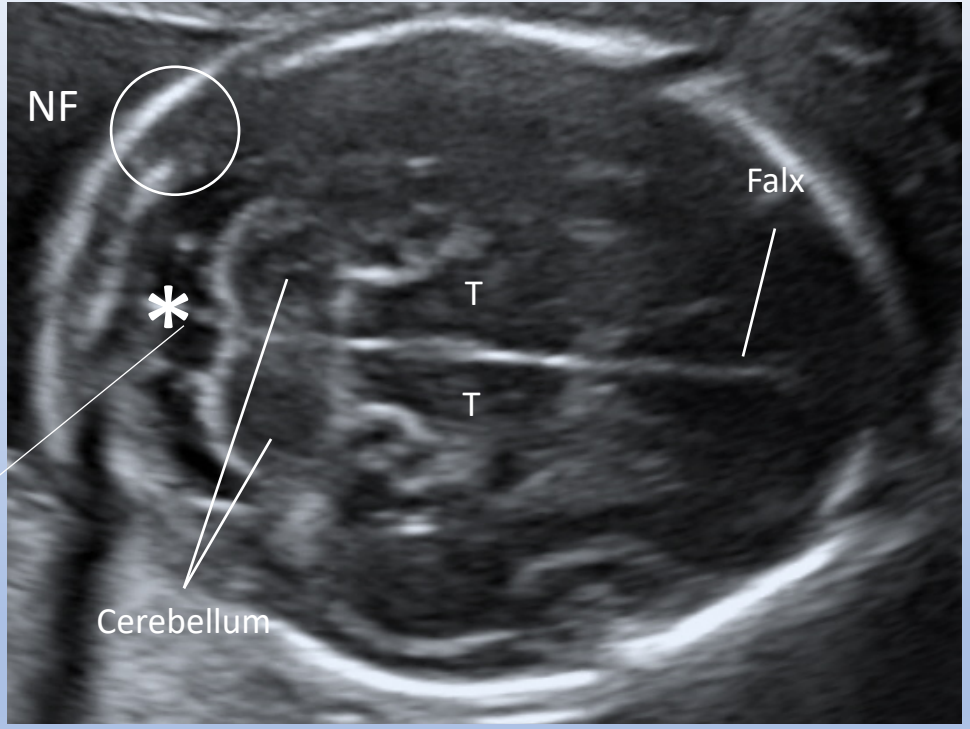
1. Midline (**falx** cerebri)
2. **Cavum septum pellucidum**
3. Rugby football shape, rounded back, more pointed at front
4. Skull contour regular
5. **Posterior horn** <10.0mm
6. **Anterior horn**(s) slit-like



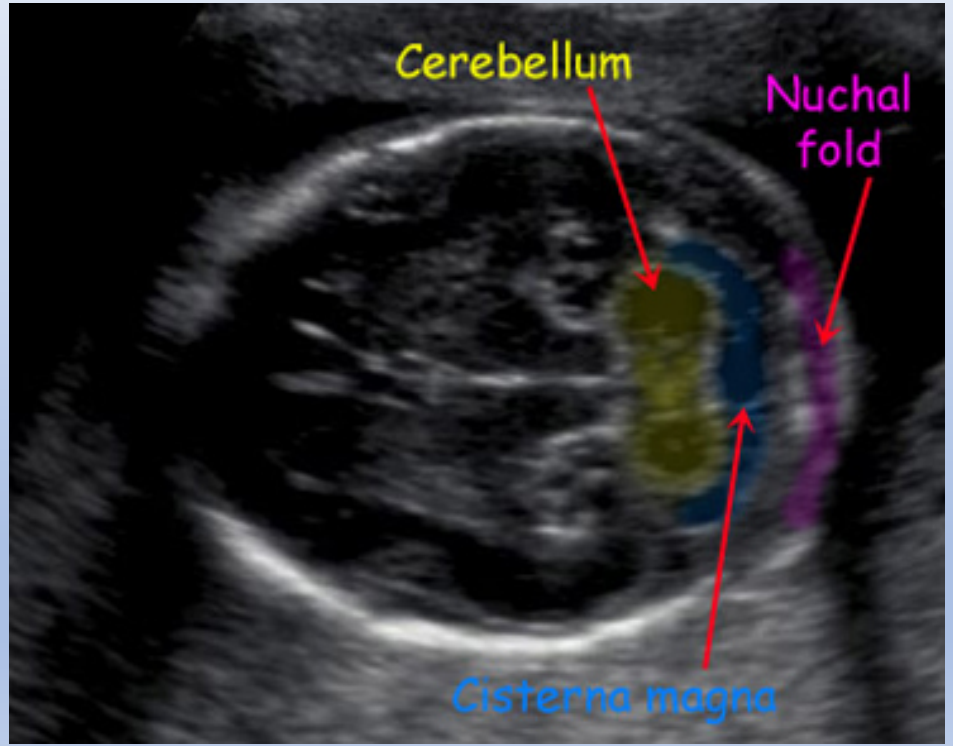
Measure BPD & HC



Posterior Fossa



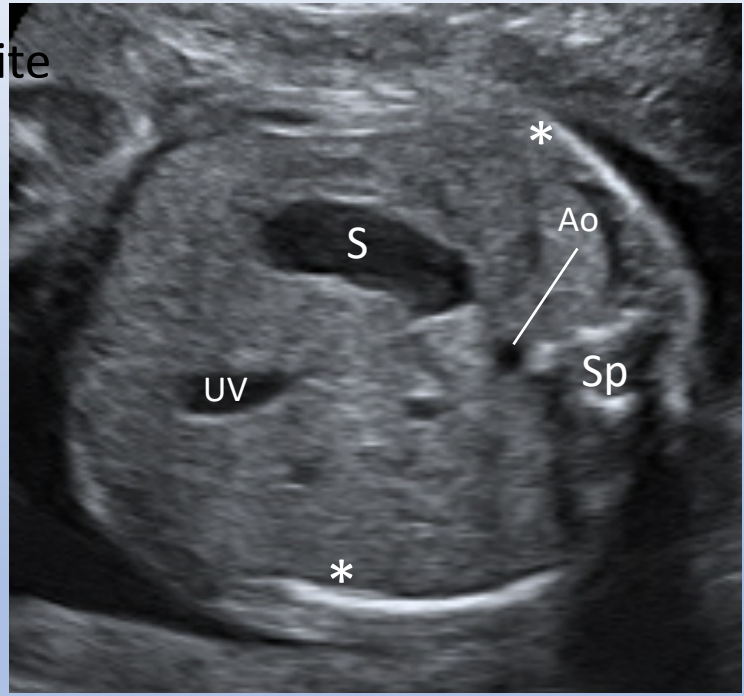
Posterior Fossa
Optimal Imaging Plane



Key Features of AC Section

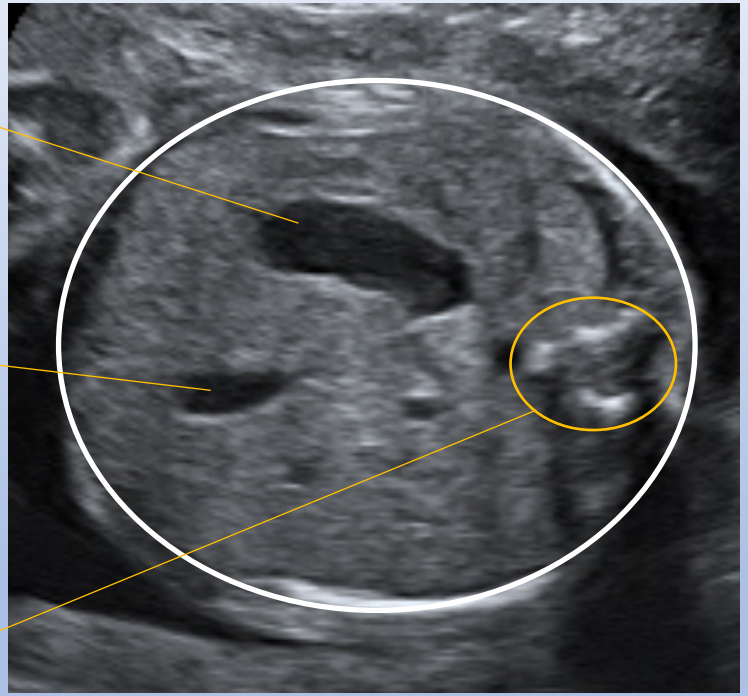
Key Features of AC Section

1. Short length of **umbilical vein**, opposite spine
2. Single **stomach** ‘bubble’, on left side
3. Remaining echotexture homogeneous
4. (Gall bladder to right of UV)
5. No fetal kidneys seen in this plane

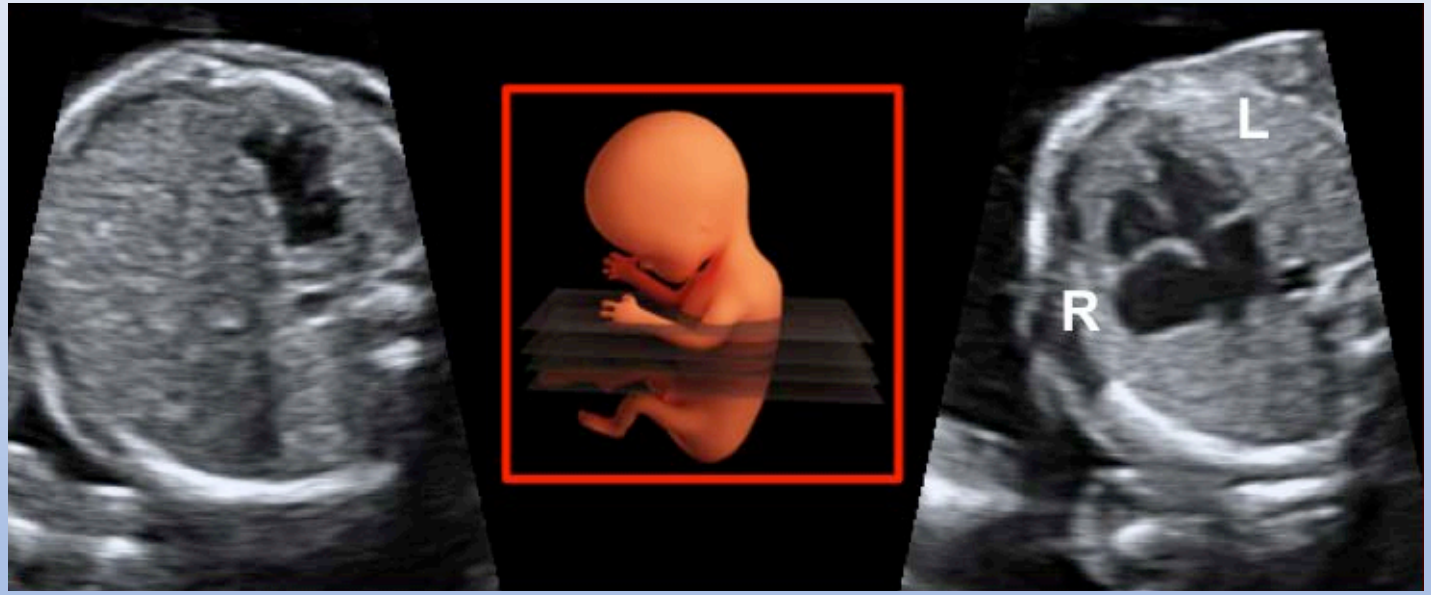


Measure AC

- Stomach
- Umbilical Vein
- True cross section of spine – 3 ossification centers



Establishing Situs



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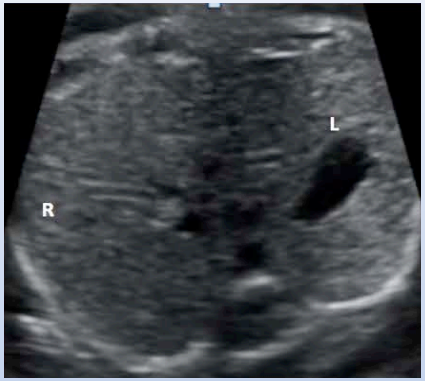
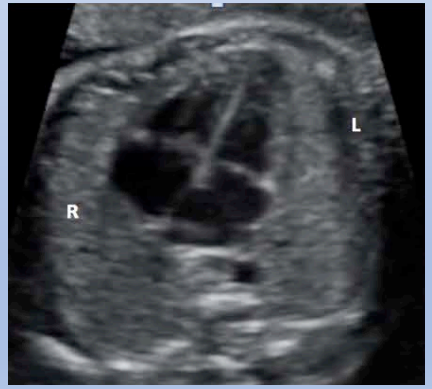
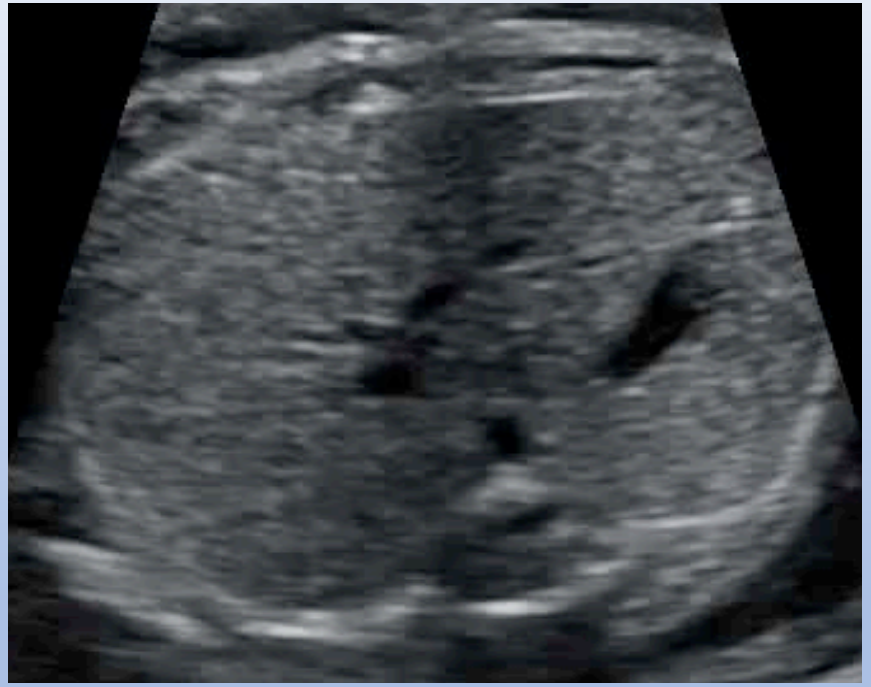
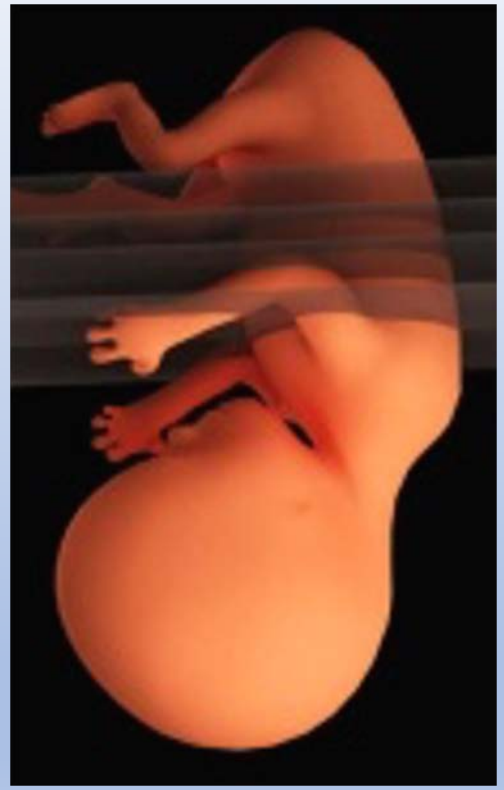






First Establish Fetal Position

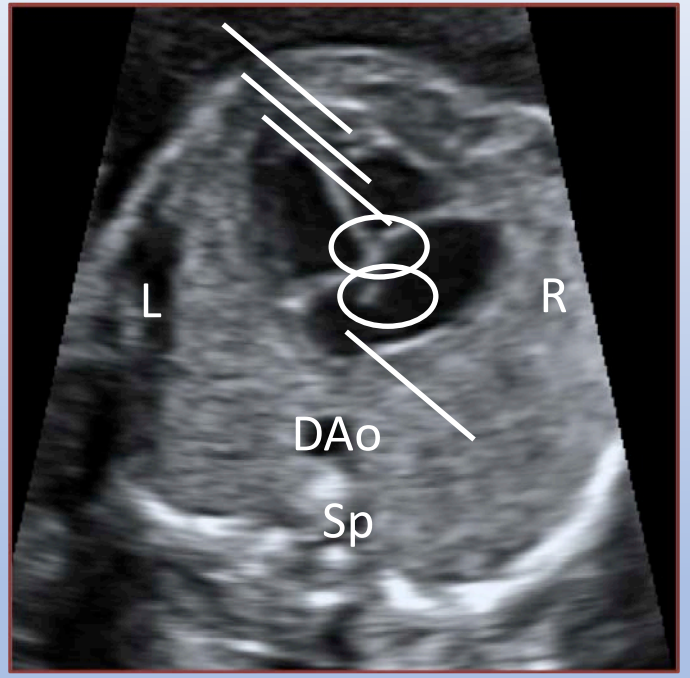


4 Chamber View

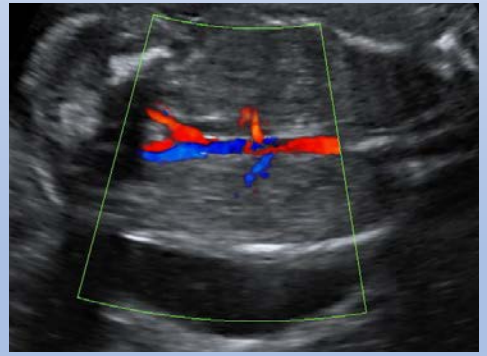
- **Easy** view to obtain
- **No specialized skill** needed
- Obtainable in **all fetal positions**
- Rules **out 60% CHD**
- Easy **slide up from AC** with full rib
- **Starting point** for the sweep

4 Chamber View – Normal Appearance

- **Right ventricle** is the most anterior, below the sternum
- **Left atrium** is closest to the spine and the most central structure in the chest
- **Tricuspid valve** is more apical than the mitral valve
- Flap of the **foramen ovale** is in the left atrium
- **Moderator band** is in the right ventricle
- **Crux** seen



Kidneys – Normal Appearance



Kidneys – Normal Appearance

- **Lateral to spine**
- Posterior to stomach
- Normal renal tissue similar echogenicity bowel, liver etc
- (Coronal view allows easier comparison)
- Cortex homogenous echopattern
- **Renal pelvis**, centrally positioned, <5.0mm A

Cord Insertion – Normal Appearance

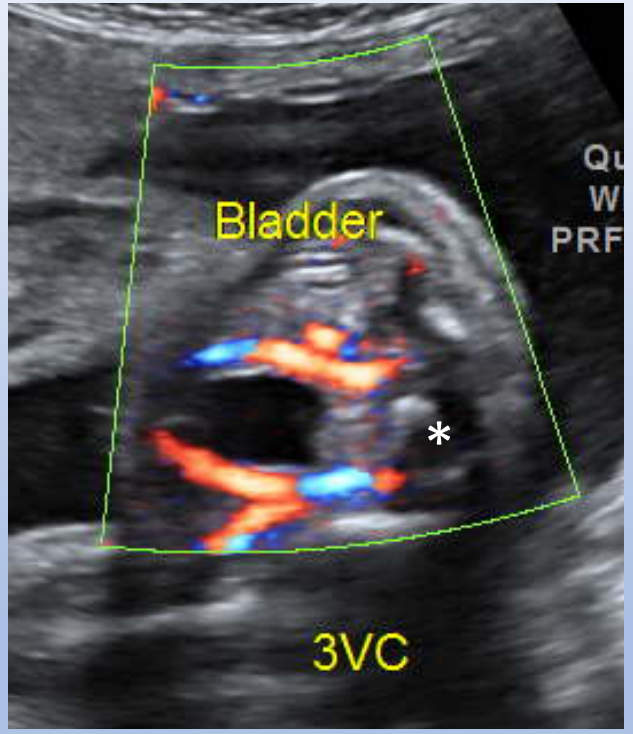
1. Slide inferiorly from AC to sacrum
2. Maintain cross sectional approach
3. Cord inserts superior to bladder

Bladder – Normal Appearance

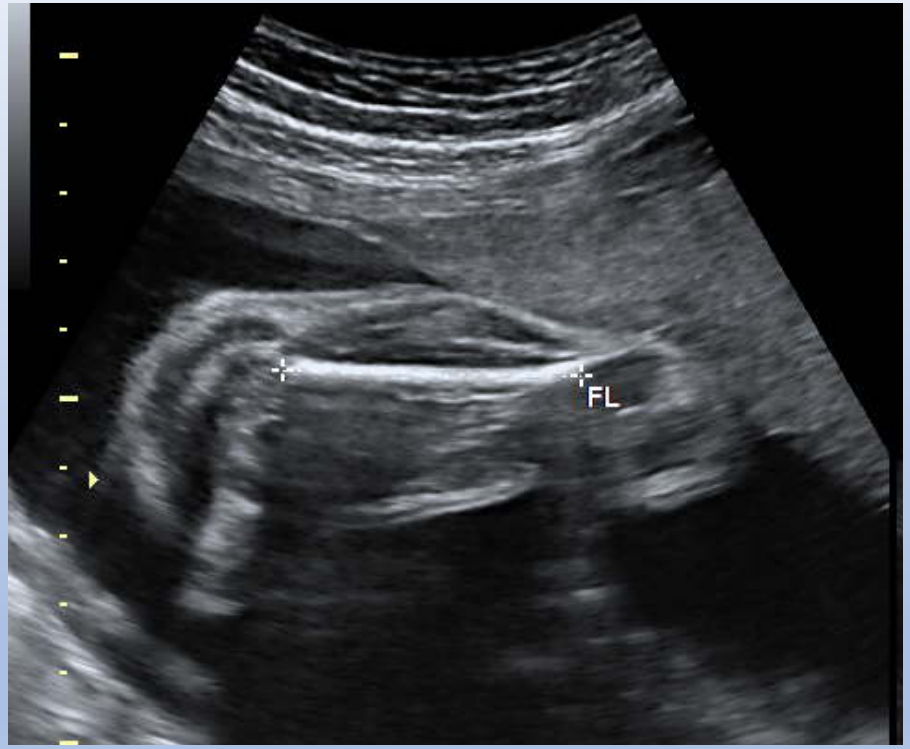
- **Central** position in fetal pelvis
- **Anterior to rectum**
- Thin walled
- No internal content

- Size varies (~30 minute cycle)

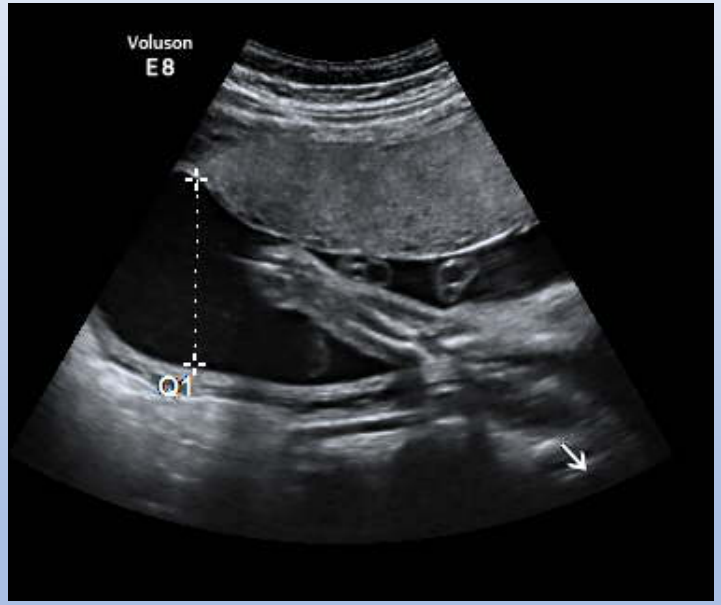
- **Umbilical artery** on each side



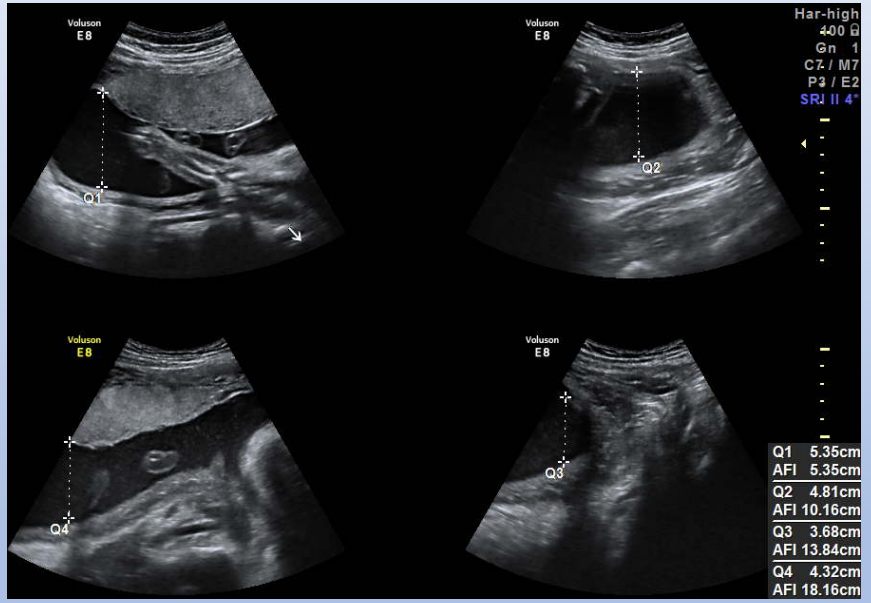
Key Features to Measure FL



Key Features of Amniotic Fluid

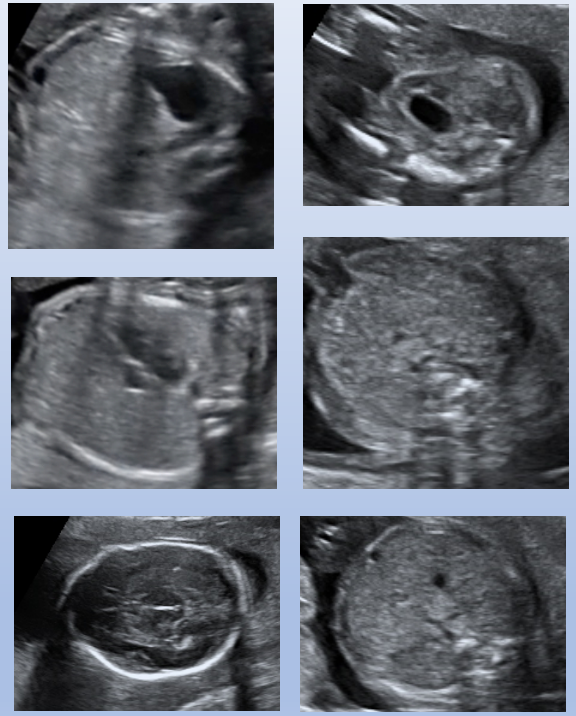


AFI: 5 – 25 cm
SDVP: 2 – 8 cm



Do not include fetal parts or umbilical cord (check with Color Doppler if unsure)

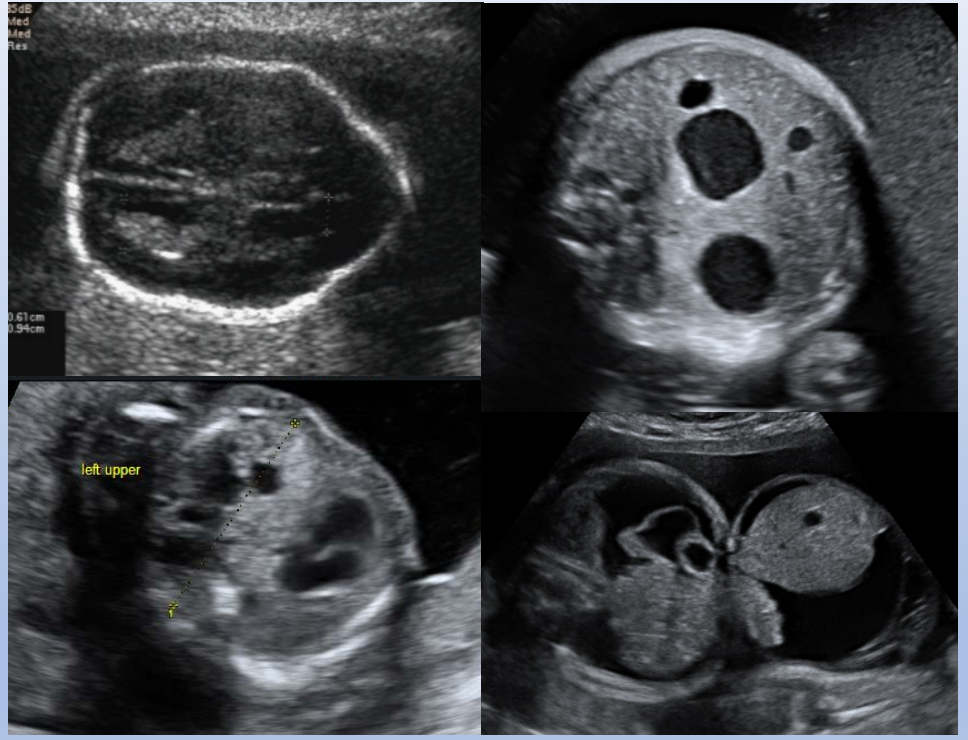
Axial Anatomic Planes



Normal or Abnormal Appearances?

Skull

1. Brain, level of ventricles
2. Brain, post fossa
3. Chest – 4 chamber view
4. Abdomen – stomach
5. Cord insertion/abdominal wall
6. Kidneys and bladder
7. Amniotic fluid
8. Size and relative size



Normal or Abnormal Appearances?

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5. Abdomen – stomach
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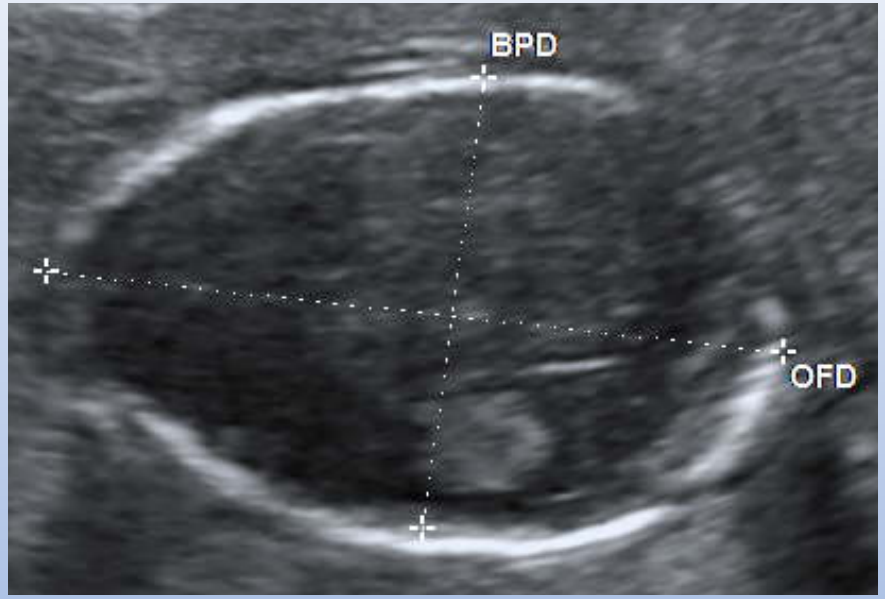
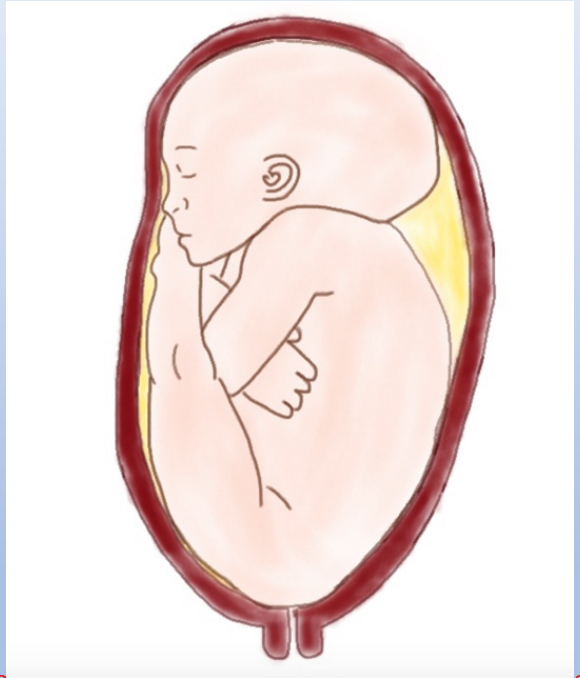
7. Kidneys and bladder
8. Amniotic fluid

Finding the HC - Shape

1. Dolichocephaly
2. Brachycephaly
3. Anencephaly
4. Encephalocele
5. Lemon sign
6. Cystic hygroma
7. Craniocynostosis

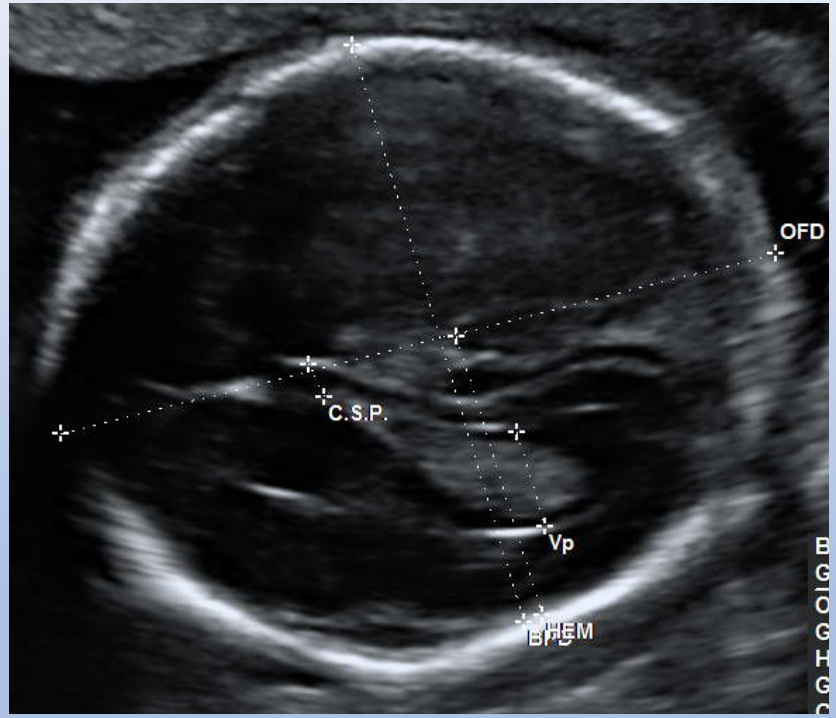
Dolichocephaly





Schematic adapted from: http://breechbirth.org.uk/2014/04/dolichocephaly-understanding-breech-head-molding/

Brachycephaly



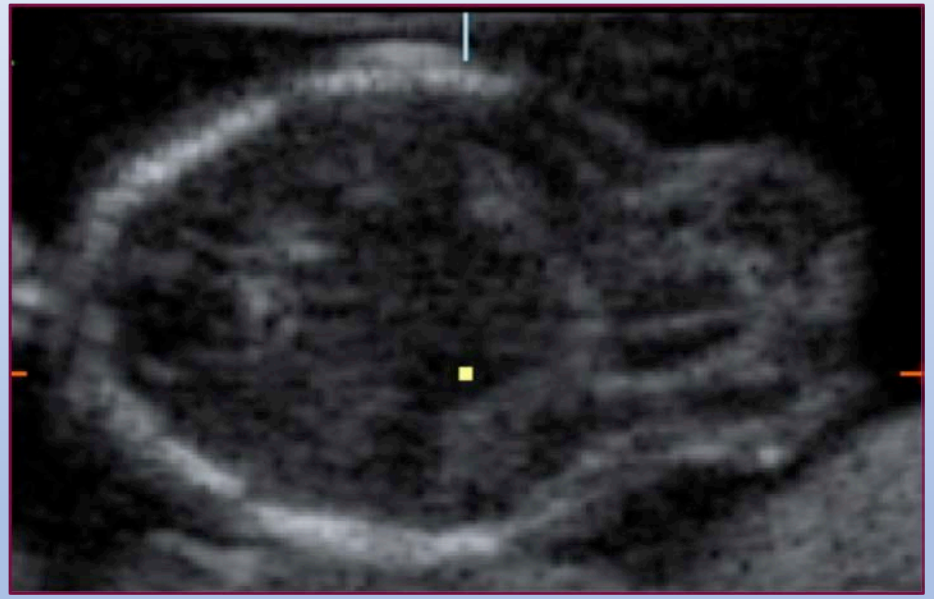
Anencephaly

Anencephaly

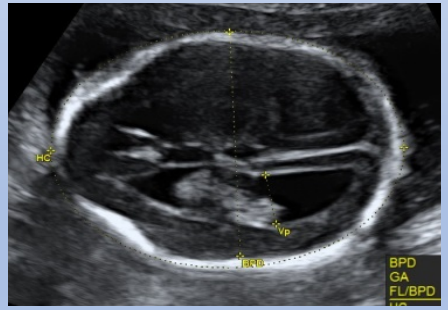
Sagittal

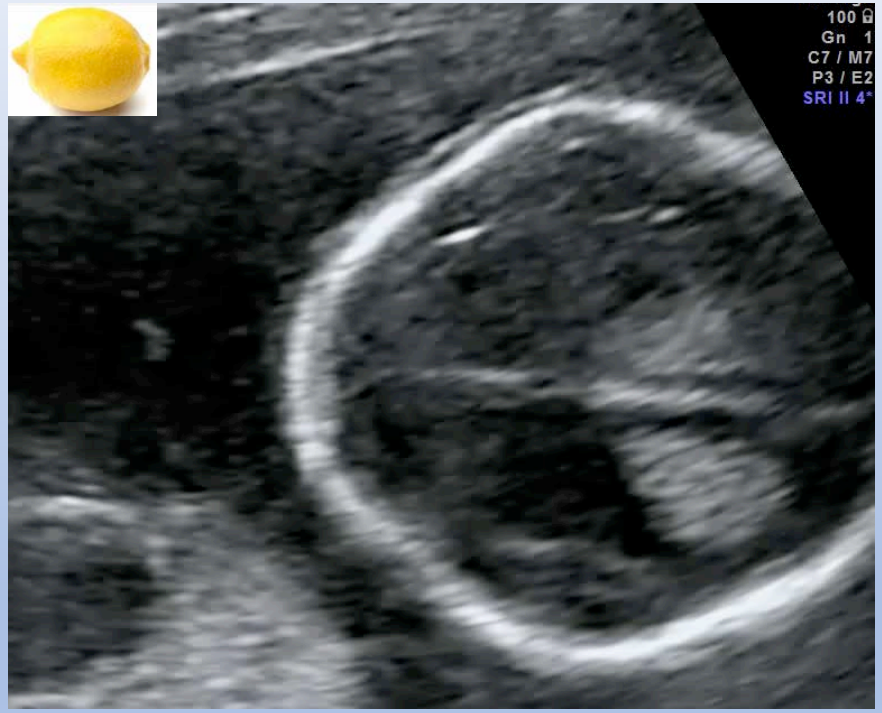
Coronal

Encephalocele

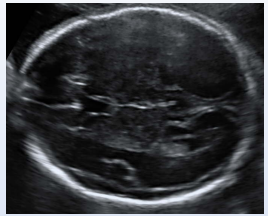


Lemon Sign

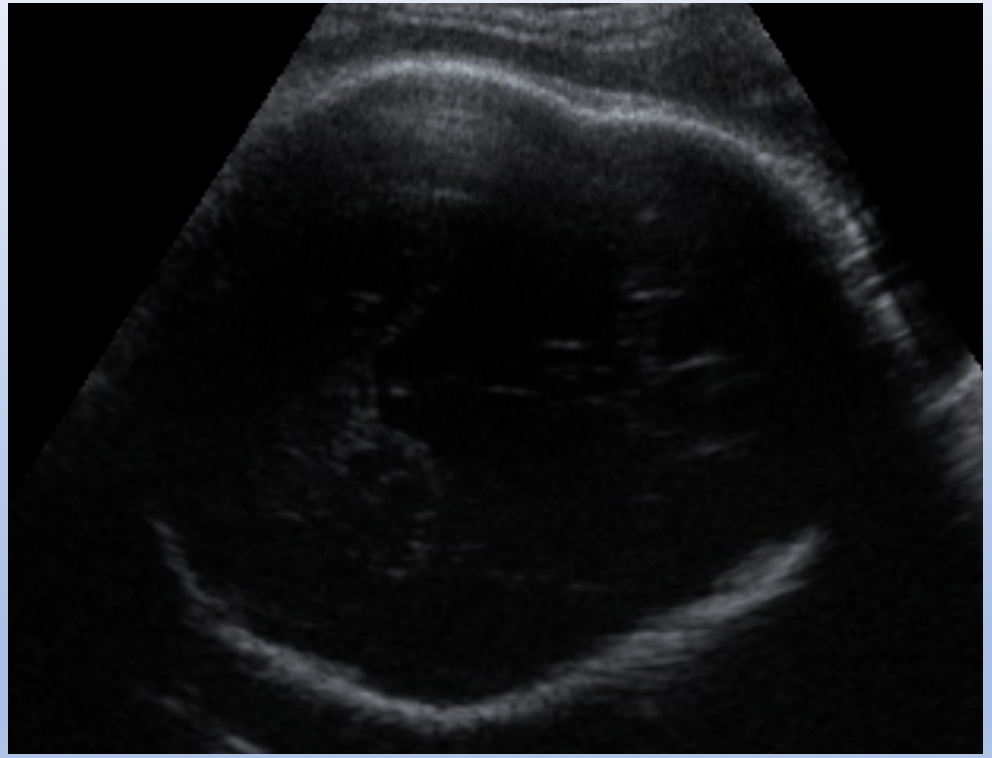


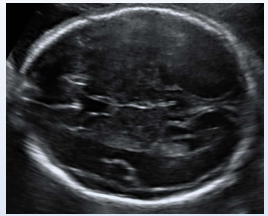


Cystic Hygroma



Craniocynostosis





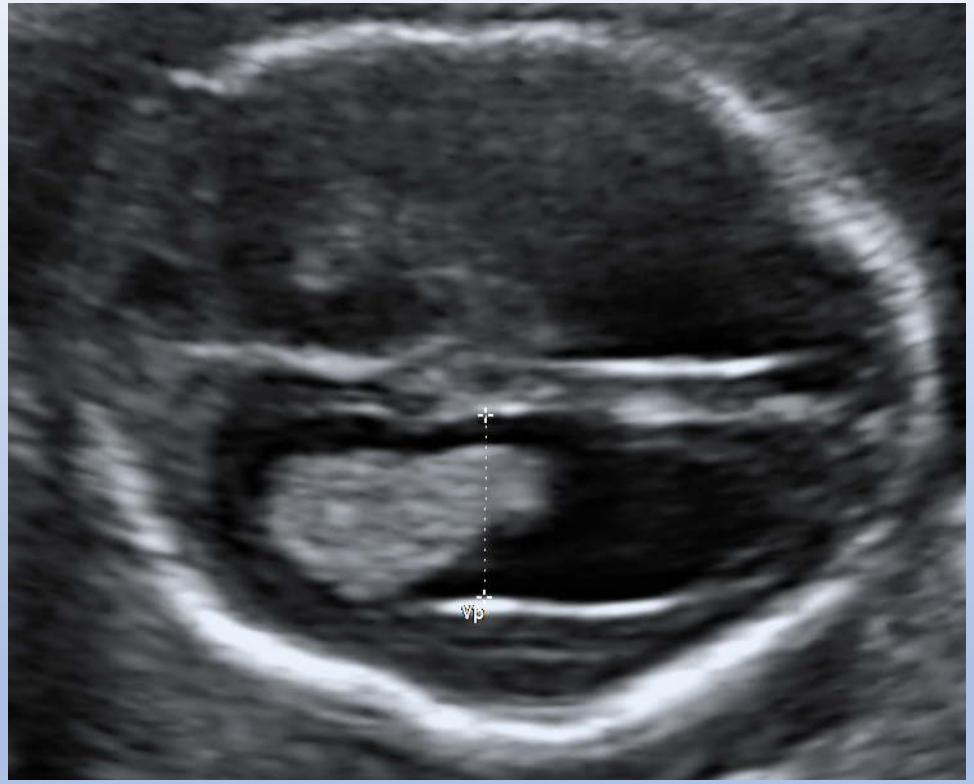
Normal or Abnormal Appearances?

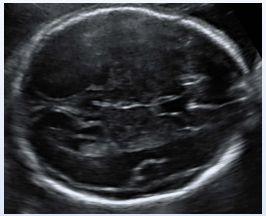
1. Skull
2. **Brain, level of ventricles**
3. Brain, post fossa
4. Chest – 4 chamber view
5. Abdomen – stomach
6. Cord insertion/abdominal wall
7. Kidneys and bladder
8. Amniotic fluid

Finding the HC – Intracranial Structures

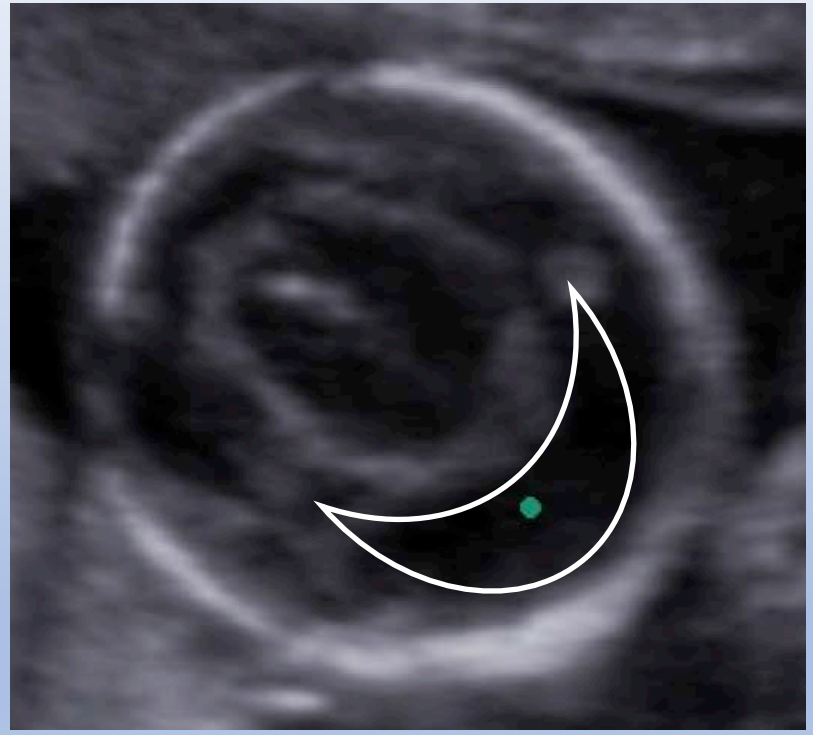
1. Ventriculomegaly
2. Holoprosencephaly

Ventriculomegaly



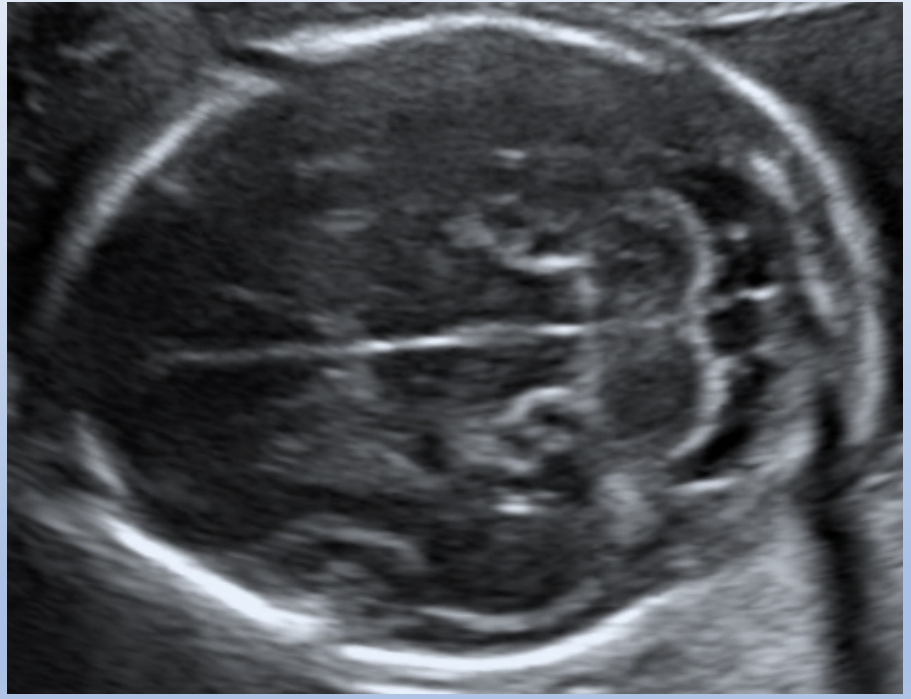


Holoprosencephaly

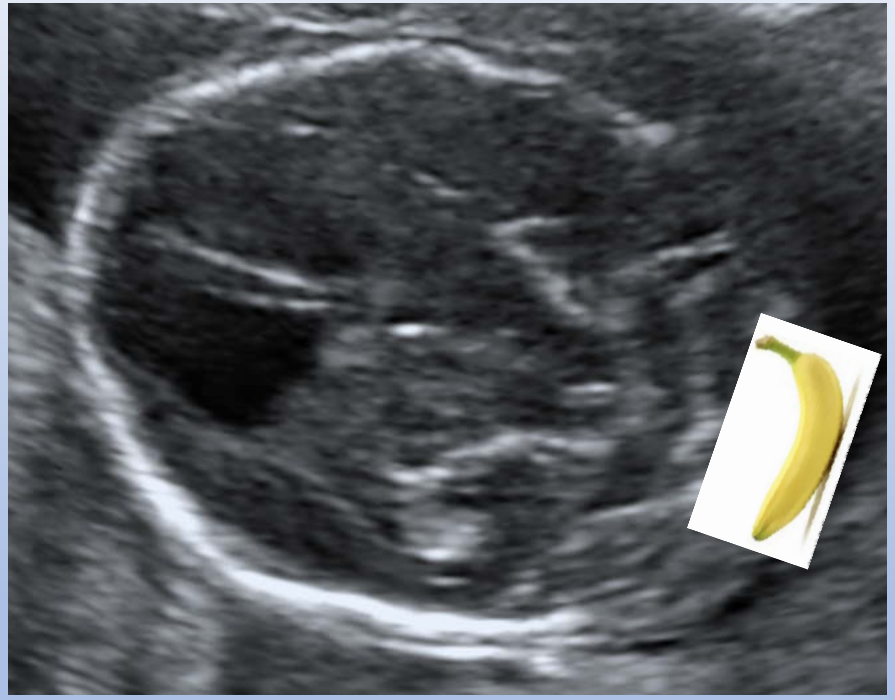


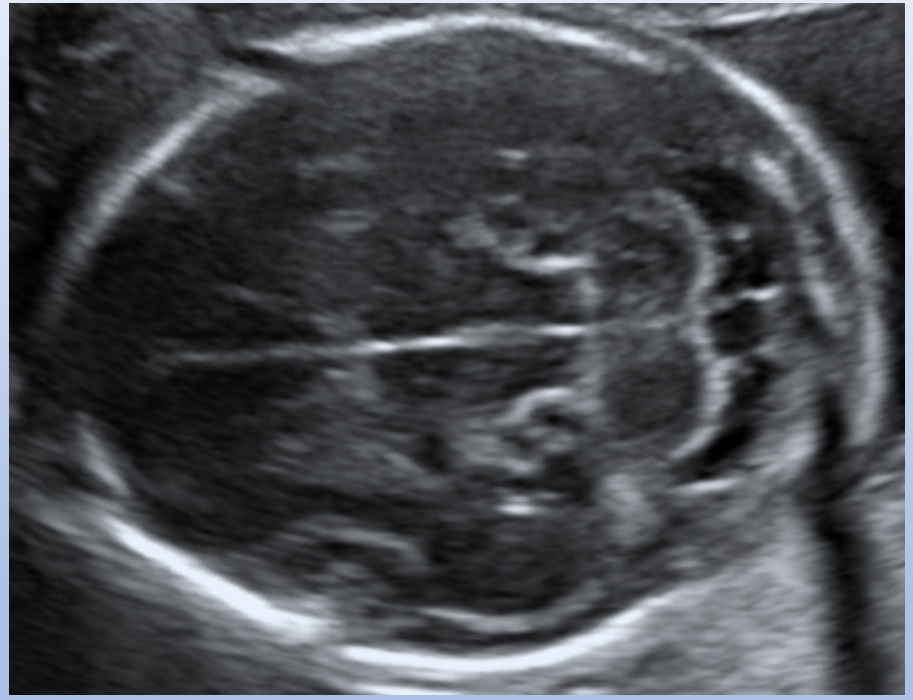
Finding the Posterior Fossa – Intracranial Structures

1. Banana sign
2. Vermian agenesis



Banana Sign

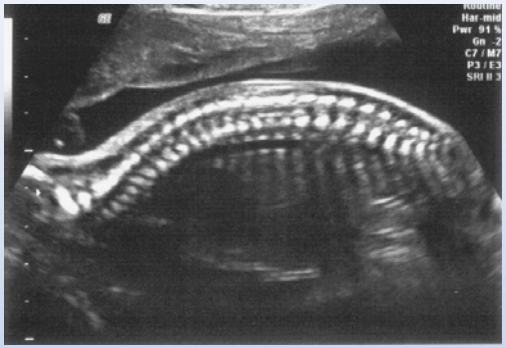
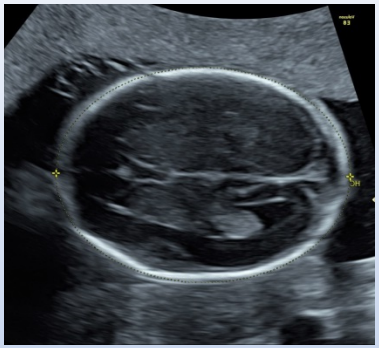
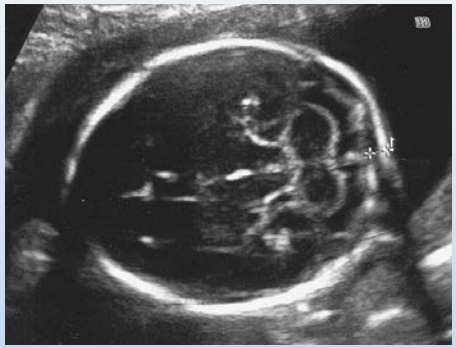




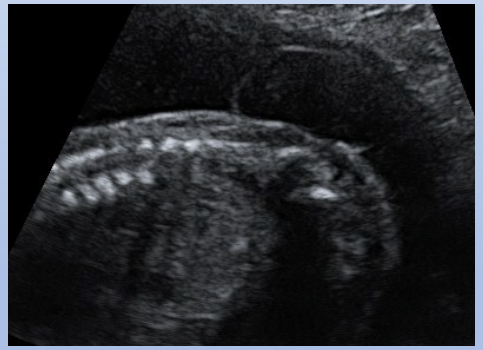
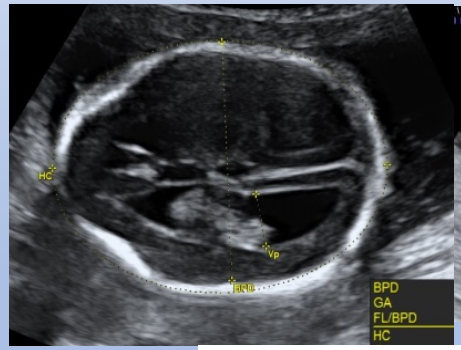
Vermian Agenesis

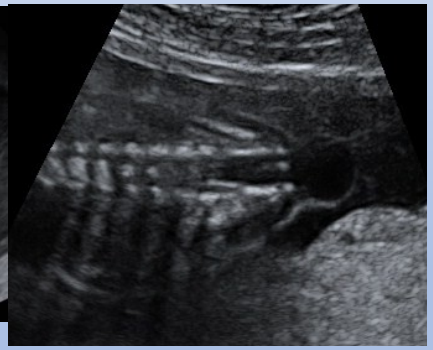
The Spine

Open Spina Bifida Typical Appearances


Normal appearances

Abnormal appearances

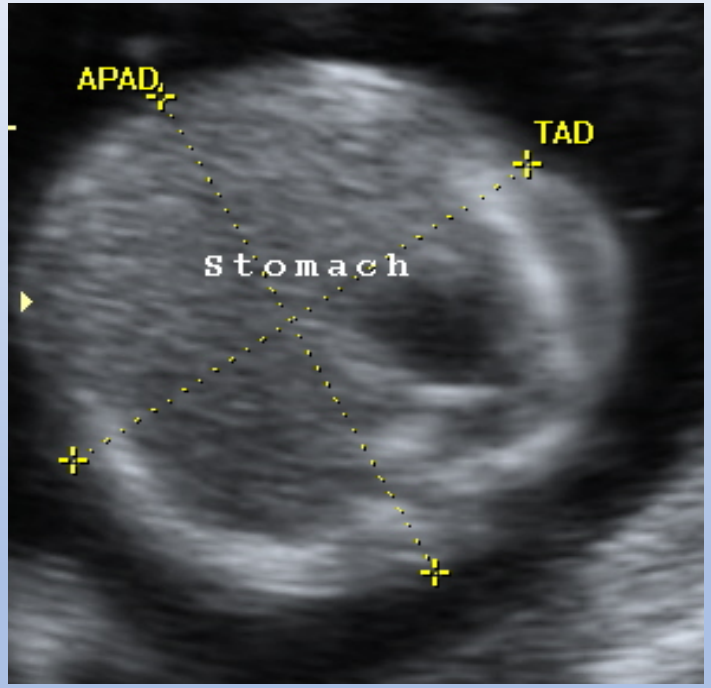
Normal or Abnormal Appearances?

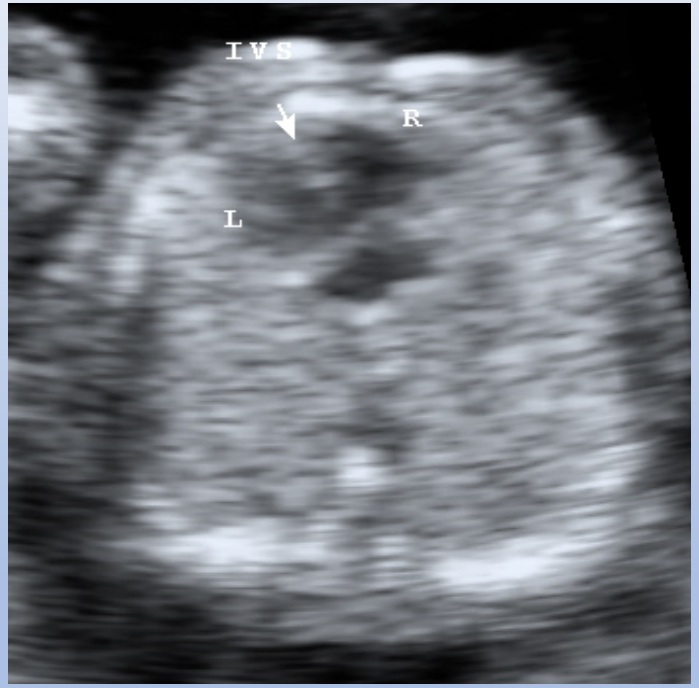
1. Skull
2. Brain, level of ventricles
3. Brain, post fossa
4. **Chest – 4 chamber view**
5. Abdomen – stomach
6. Cord insertion/abdominal wall
7. Kidneys and bladder
8. Amniotic fluid

Finding the 4 Chamber View

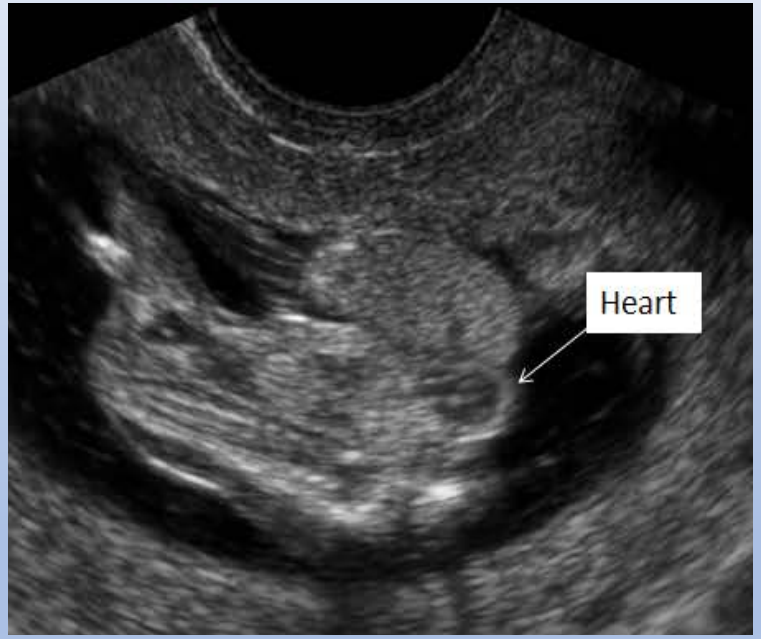
1. Situs abnormalities
2. Ectopia cordis
3. Univentricle
4. AV canal
5. CDH

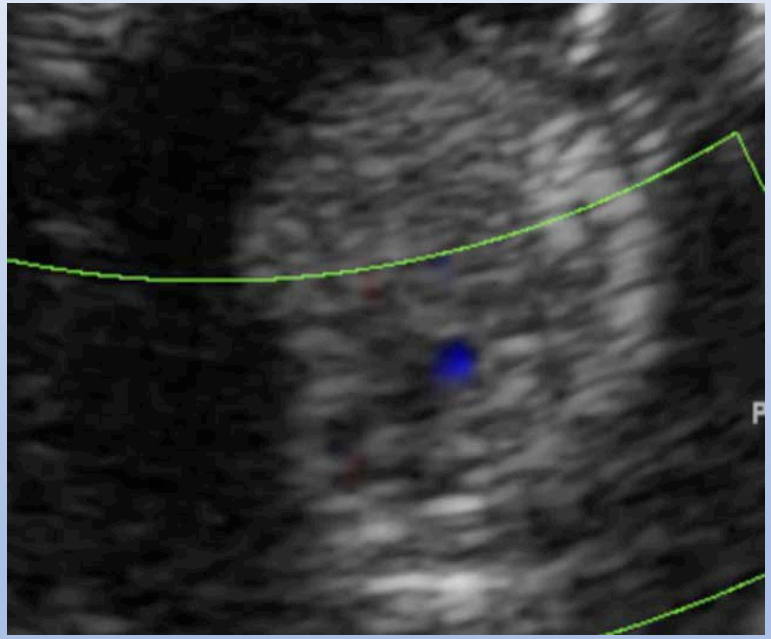
Abnormal Situs



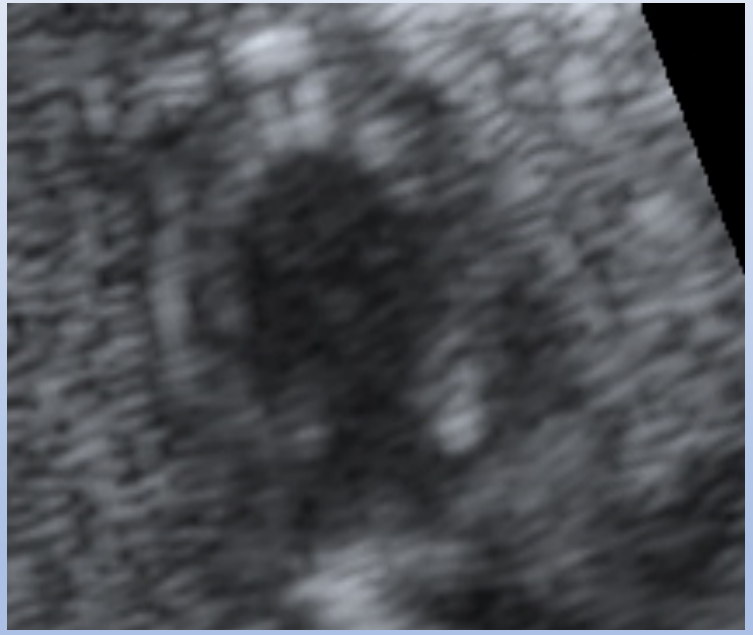


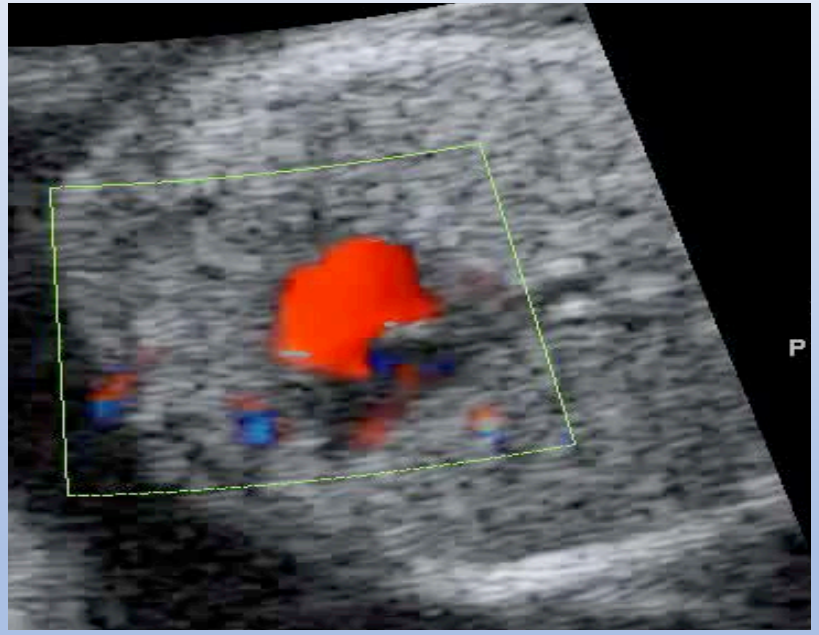
Ectopia Cordis



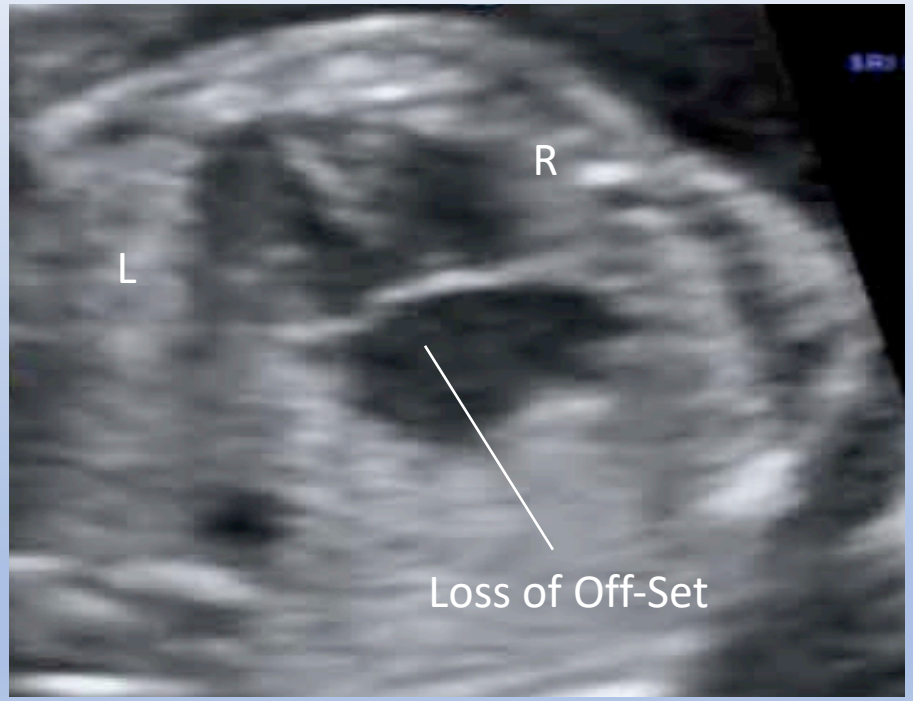


Univentricle

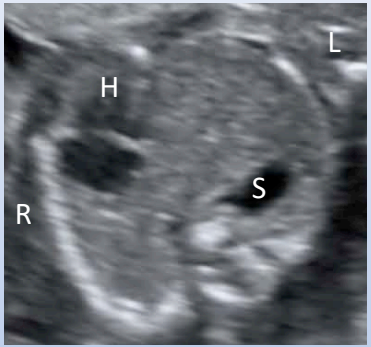


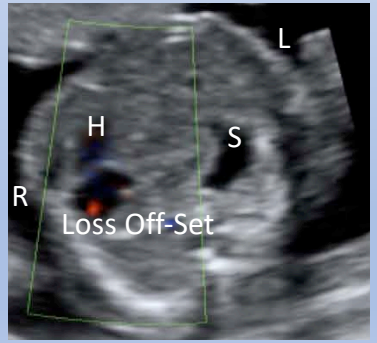


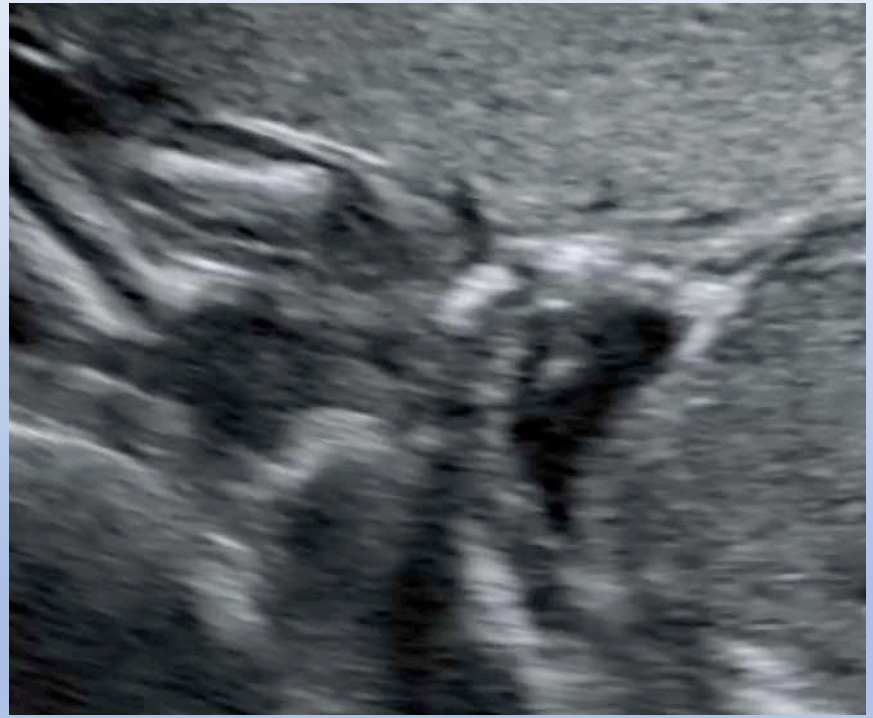
Atrioventricular Septal Defect



Congenital Diaphragmatic Hernia







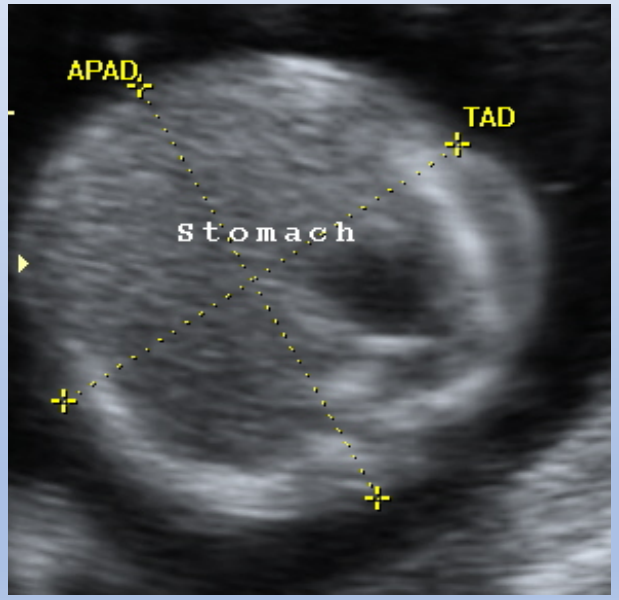
Normal or Abnormal Appearances?

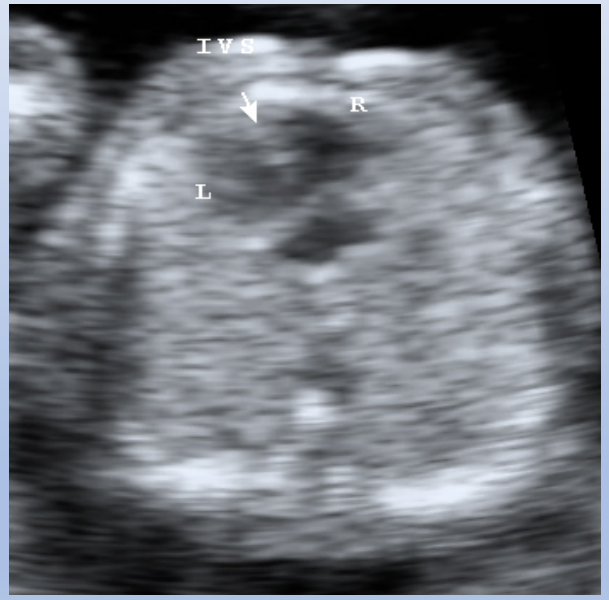
1. Skull
2. Brain, level of ventricles
3. Brain, post fossa
4. Chest – 4 chamber view
5. **Abdomen – stomach**
6. Cord insertion/abdominal wall
7. Kidneys and bladder
8. Amniotic fluid

Finding the AC

1. Establishing situs
2. Absent stomach: esophageal atresia
3. Double bubble: duodenal atresia

Establishing Situs





Absent Stomach

15 Mins Later

Absent Stomach

Double Bubble Sign

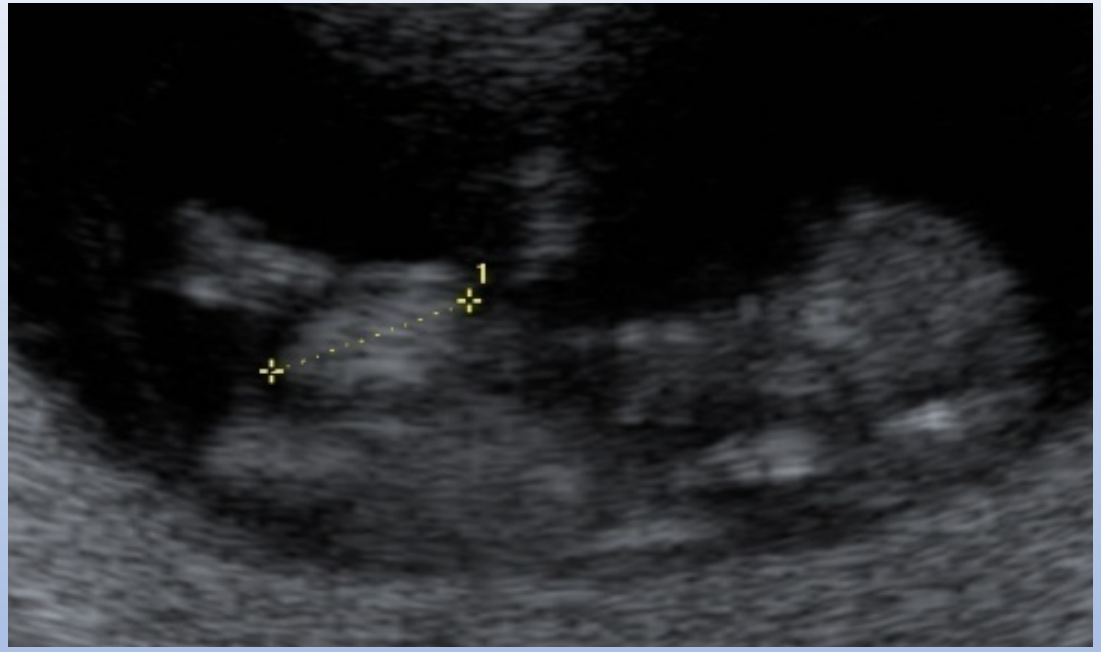
Normal or Abnormal Appearances?

1. Skull
2. Brain, level of ventricles
3. Brain, post fossa
4. Chest – 4 chamber view
5. Abdomen – stomach
6. **Cord insertion/abdominal wall**
7. Kidneys and bladder
8. Amniotic fluid

Cord Insertion/Abdominal Wall

1. Normal gut herniation
2. Omphalocele
3. Gastroschisis

Normal Gut Herniation



Fetuses have exompholos at 9-10 weeks that resolves by 12 weeks

Omphalocele

Abnormal cord insertion

- Cord inserts into apex of defect
- Contains liver +/- bowel etc
- Membrane covered

Gastroschisis

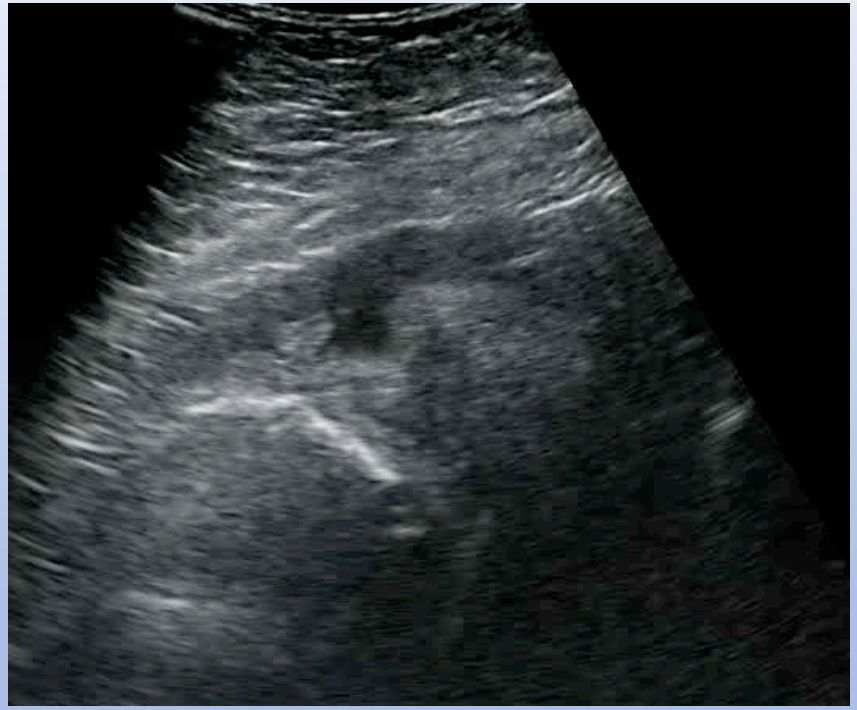
Normal cord insertion

- Defect below and to right of cord insertion
- Contains bowel only
- Free floating – no covering membrane

Normal or Abnormal Appearances?

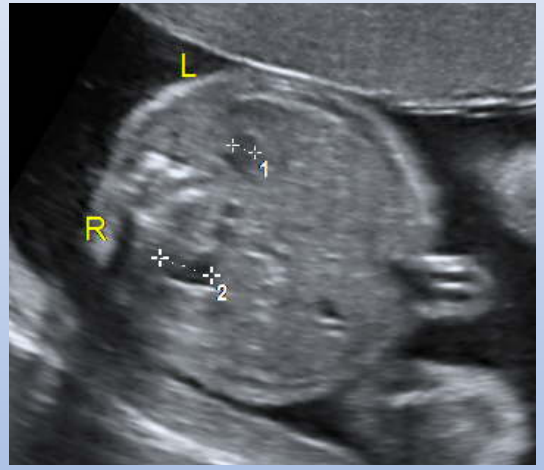
1. Skull
2. Brain, level of ventricles
3. Brain, post fossa
4. Chest – 4 chamber view
5. Abdomen – stomach
6. Cord insertion/abdominal wall
7. **Kidneys and bladder**
8. Amniotic fluid

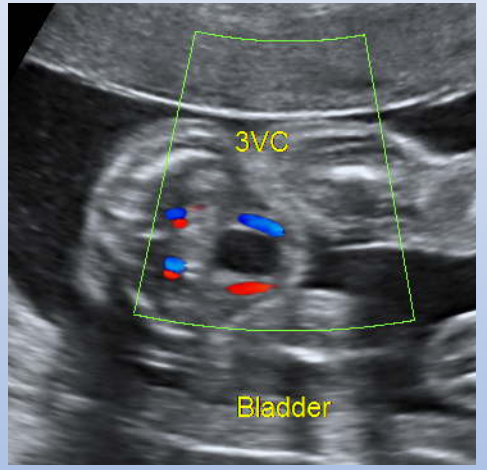
Kidneys and Bladder



Kidneys and Bladder

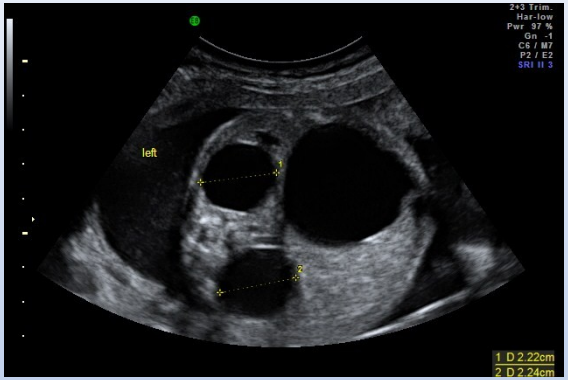
1. Renal agenesis
2. Hydronephrosis
3. Bladder outlet obstruction





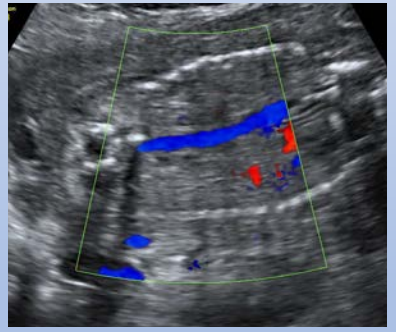
Urinary Tract Obstruction

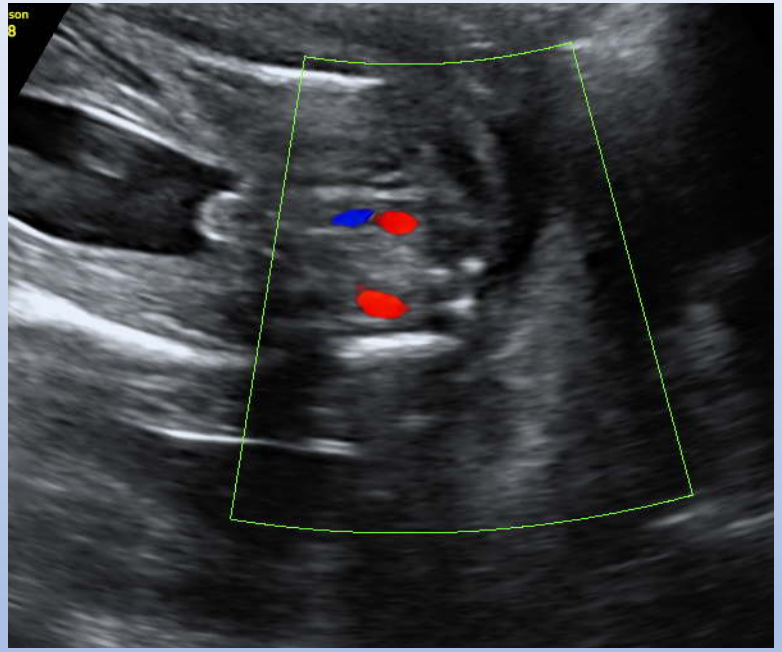
1. Appearances dependent on
   - Site of obstruction
   - Unilateral or bilateral



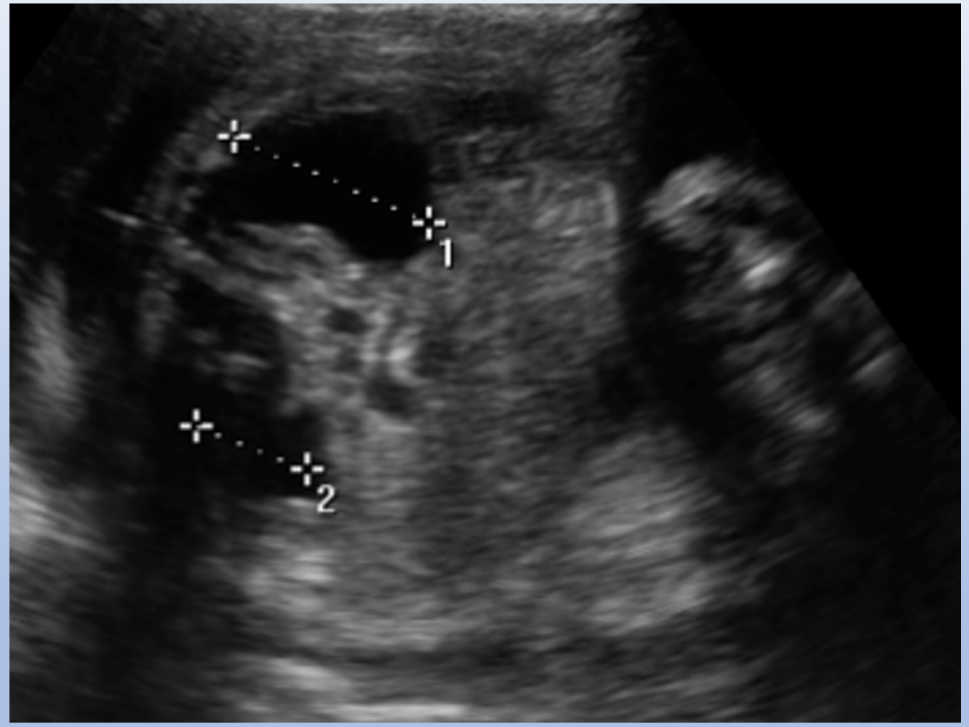
2. Amniotic fluid volume
   - Oligo/anhydramnios – bilateral and/or low (bladder outet)
   - Normal fluid - unilateral

Renal Agenesis

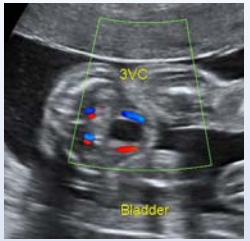


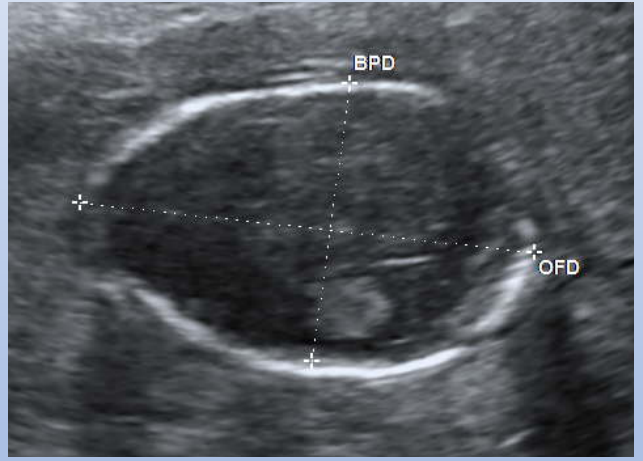


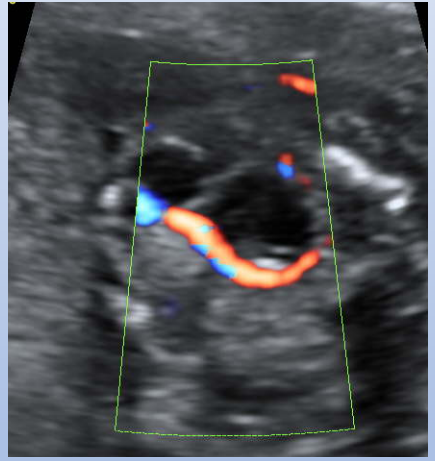
Hydronephrosis



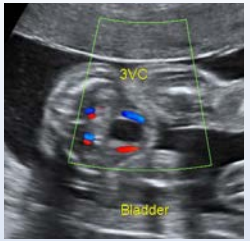
Bladder Outlet Obstruction







Bladder Outlet Obstruction



Normal or Abnormal Appearances?

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6. Cord insertion/abdominal wall
7. Kidneys and bladder
8. **Amniotic fluid**

Oligohydramnios: Causes

TABLE 9.1	Common Causes of Oligohydramnios

- Premature rupture of membranes
- Genitourinary abnormalities
- Uteroplacental insufficiency
- Postdates pregnancies

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Polyhydramnios: Causes

TABLE 9.2	Common Causes of Polyhydramnios

- Gestational and pregestational diabetes
- Isoimmunization
- Fetal structural and chromosomal abnormalities
- Fetal infections
- Multiple pregnancies with Twin-Twin Transfusion Syndrome
- Idiopathic

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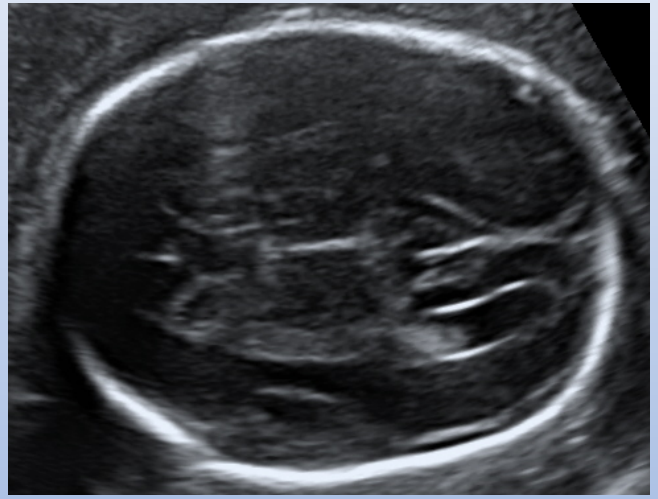
Relative Sizes



Key points

1. The key to identifying abnormalities is understanding the range of normal appearances at differing gestations

2. It is important to develop a consistent approach to each scan, rather than scanning randomly

3. Find the long axis of the fetus first and assess the appearances

Key points

4. Then assess the fetal anatomy in cross section starting with the head, assess skull and intracranial anatomy, measure the HC

5. Slide through the chest to the abdomen, assess situs, chest contents and upper abdomen, measure AC

6. Find FL by continuing to slide through lower abdomen and pelvis, assess abdominal wall, cord insertion, kidneys, bladder, spine and skin covering

Conclusions

Distinguishing between normal and abnormal ultrasound appearances requires:

- The development of a consistent scanning technique
- Paying rigorous attention to the quality of sections obtained
- Understanding how to manipulate the probe to improve poor sections
- Appreciating how the range of normal appearances, and therefore potentially abnormal appearances, changes with gestation

Questions?

- bloe@rad-aid.org